POWER

Volume 56 New York, October 24, 1922 *Number* 17

Trade Interest vs. Individual Interests

THE editor, who must have an ear for all and an eye for everything, is quick to sense a change in conditions and dispositions in the industry that he serves.

It has been a source of satisfaction to remark the waning of bitterness between competitors. There is less disposition on the part of salesmen to take up the best part of an interview in telling what a contemptible no-account the other fellow is and what little right his goods have to cumber the earth. It is less embarrassing to admit in the presence of one manufacturer or salesman that you have a speaking acquaintance with another.

Engineering societies and especially trade organizations have done a great deal to bring this betterment about. Men have been led to look up over the file of orders that they got—and especially those that they did not get—and to consider their industry as a whole.

They have seen that it is better to join with their competitors in demonstrating the advantages of the type of apparatus that they jointly offer over competing methods or systems, to work together to improve in the service that their collective industry can perform, to enhance the public estimate and cultivate a general favorable impression of the efficiency, dependability and usefulness of their common type of apparatus than to stultify and disparage the whole industry by proclaiming the failures and shortcomings of individual companies or firms.

The personal contact brought about at meetings of such organizations has had a softening and humanizing effect. One is not so prone to vilify a man with whom he has played a round of golf, whose family he has met and into whose eyes he has looked across a dinner table. Many of the grievances that have festered and irritated have disappeared through association in the conference chamber or in a frank exchange of confidences and cigars.

In recent interviews and correspondence I have noticed with regret recrudescences of the old animosity. Is it a natural accompaniment of a period of increasing tenseness of competition? Must we await the passing of the old-time, narrow-visioned sales manager before we can have a complete realization of the broader, better merchandizing spirit?

F. R. Low

Proposed 450,000-Hp. Development at Niagara Falls

AT VARIOUS times different plans have been suggested for developing power at Niagara Falls and transmitting it to New York City. The latest project is that proposed by the American Super-Power Corp., Buffalo, N. Y., for which F. W. Ballard & Co., Cleveland, Ohio, are the engineers. A report has recently been issued by the engineers, and the following data have been taken from this report:

The plan proposes the development of 450,000 hp., taking the water through a canal from about four miles above the Falls and discharging it into the lower gorge near Lewiston under an effective head of 301 ft. The plan also includes the building of a four-circuit transmission line from the power house to the metropolitan district of New York City, a distance of 315 miles, over a private right-of-way for the transmission of 400,000 hp. at 220,000 volts.

Canal and Power House

The water from the intake at the river's edge to the gatehouse at the bluff above the power house will have a course of about 36,000 ft., or 6¾ miles. Exclusive of the forebays and gatehouse, the length of the canal proper will be approximately 34,400 ft. The proposed route is shown in Fig. 1, and runs from the intake in a northerly direction for a distance of about 16,000 ft., at which point a long-radius curve carries it in a northwesterly direction. Between the end of the canal proper and the main gatehouse on the bluff above the power house, a distance of 600 ft., the canal section widens out from 62 ft. 6 in. to 318 ft. at the base of the gatehouse, thus forming a forebay. This increased section of area slows down the velocity of the water 6 ft. per sec. at the

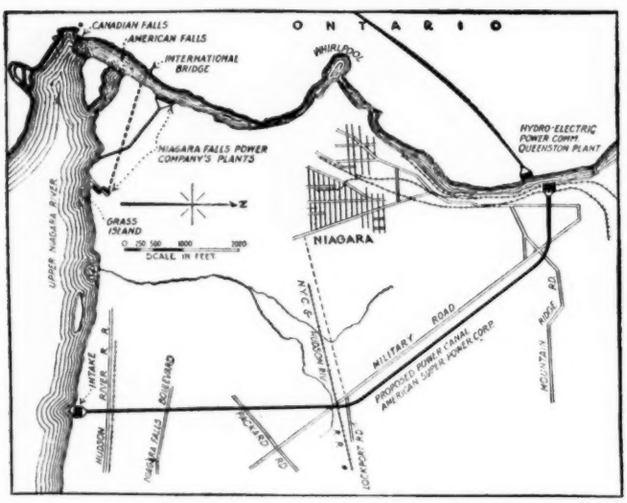


FIG. 1—NIAGARA RIVER AND PROPOSED ROUTE OF THE POWER CANAL

entrance to a velocity of about 1 ft. per sec. by the time it reaches the gatehouse. The gatehouse will have a length of 334 ft. and a width of 52 ft. and is to be two stories high. The water will be carried to the turbines in the power house by nine penstocks, there being a separate penstock for each generating unit. These penstocks will be tunneled through the rock overlooking the power station and concrete lined for their entire length, the center line forming an angle of nearly 45 deg. with the horizontal. The inside diameter of the finished penstock is to be 13 ft. 6 in.

In the power plant the generating equipment will consist of nine units rated at 50,000 hp. each. Using

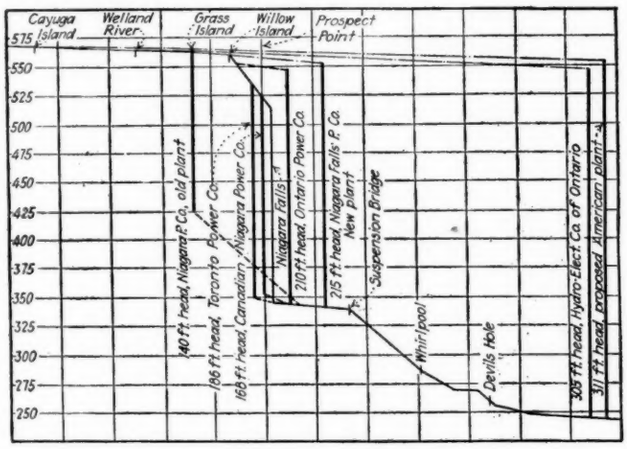


FIG. 2—PROFILE NIAGARA RIVER FROM CAYUGA ISLAND TO LEWISTON, SHOWING HEAD AVAILABLE AT THE VARIOUS POWER PLANTS

15,000 cu.ft.-sec. of water at the head that will be available with the canal and penstocks as designed, it will be possible to develop 450,000 hp. The turbines will be of the vertical-shaft type connected to a 45,000-kva. 12,000-volt generator. It is proposed to have the transformers directly connected to the generators without any intervening switches, therefore each generator and bank of transformers will operate as a complete unit, paralleling of the units desired being made on the high-tension side of the transformers. This scheme of connections will eliminate all the extremely heavy switching equipment that would be necessary if any connection for paralleling were attempted on the low-tension side of the transformers.

Estimated Cost of Development

The cost of a generating station of 450,000 hp. capacity, together with the cost of a canal approximately seven miles long, is given as $34,186,150. For the four-circuit transmission line with step-up transformer station at the receiving end, and step-down transformer station at the terminal, including everything complete, the cost is figured to amount to $27,457,655. A total cost for generating station and transmission line of $60,000,000 has been used. For delivering power over the transmission line to New York City, a load factor of 85.7 per cent has been assumed, which is equivalent to 7,500 hours per year at full load. Allowing a 15 per cent loss in the system would result in delivering 340,000 hp. at the terminal station, and at a load factor of 85.7 per cent would deliver 1,912,500,000 kw.-hr. per year. Taking the amount to be earned on the investment as 15 per cent, the total earnings per year will be $9,000,000, which will allow selling the power at the terminal station in New York for $35.30 per kilowatt-

year, or 0.47c. per kilowatt-hour. This estimate is based on allowing the system to carry the base load for the metropolitan district and allow the peak load to be carried on the steam plants. It is considered that a load of 85 per cent load factor for the full capacity of the transmission line would be obtained. The figure 85.7 per cent load factor has been used to give an even number of hours.

The production, not including distribution, costs for all five companies in New York for the year 1920 averaged one cent per kilowatt-hour, and to these costs should be added the fixed costs to cover interest, depreciation and taxes on the investment. It is estimated that the saving to all the companies under such conditions will amount to $15,000,000 per year, without making any deduction for the fixed costs on idle equipment. However, allowing a conservative estimate for the fixed costs, there would still be a yearly net saving to the power companies of New York City, by the use of Niagara power, of somewhere between ten and fifteen million dollars.

It is proposed to locate the terminal station at Yonkers, N. Y. This station would consist of the plant and equipment for transforming the high-tension voltage of 220,000 volts to 11,000 or 22,000 volts for local distribution in New York City and vicinity. It has been figured tentatively on installing in the terminal station five synchronous rotary condensers of 35,000-kva. capacity each.

Combination Power and Ship Canal

In the interests of conservation, and for the improvement of navigation of the water resources of the Niagara frontier, and also of the Great Lakes, it has been deemed best to consider a combination of the power canal of the American Super-Power Corporation and the projected ship canal from Lake Erie to Lake Ontario on the La Salle-Lewiston route, which was surveyed and reported on by the United States Board of Engineers on Deep Waterways under date of June 30, 1900. Studies on the foregoing combination for combined power and ship canal have been made, and it has been found that the power canal can be very readily increased in width and made to serve as a ship canal. The prism adopted for the La Salle-Lewiston ship canal gives a waterway 230 ft. wide with a water depth of 30 ft. A flow of 15,000 cu.ft.-sec. is contemplated for power purposes, and an average of 3,000 cu.ft.-sec., more or less, in addition for lockage and canal losses. Power for the operation of the locks would be supplied by the power company. The most important point to be considered in the design of a combination power and ship canal is to limit the velocity of the water to such a figure that it will not be objectionable for navigation purposes. This velocity will not be exceeded when the canal is used for both power and navigation purposes with a maximum allowable flow of water being utilized for power purposes.

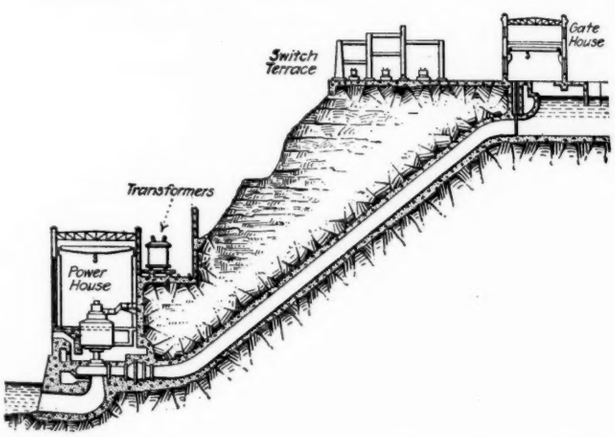


FIG. 3—SECTION THROUGH PROPOSED POWER PLANT

FIG. 4—MAP SHOWING ROUTE OF PROPOSED 220,000-VOLT TRANSMISSION LINE

Where steam passes through a nozzle or orifice, some of the heat contained is turned into energy of motion which may be recovered, in large part, by the blades of a turbine. If, however, the steam after passing through the orifice or nozzle, is not permitted to do useful work, it will "wear out" its velocity in fluid friction. In the process it gets back the amount of heat it lost in passing through the nozzle, so that the final heat in the steam is the same as before it entered the nozzle. There is, of course, a drop in pressure. If the steam is saturated at the start, it will have to be superheated at the lower pressure to hold the same amount of heat. In such a case the final temperature can be determined directly from the steam tables by first looking up the total heat of saturated steam at the original pressure and then hunting for the same total heat opposite the final pressure in the superheat tables.

In France public sentiment is strong for the utilization of water power to overcome the dependence upon foreign imports of coal. The extent of this interest is shown by the fact that in 1913 only 930,000 water horsepower was installed, while in 1921 a total of 2,100,000 hp. was in use. Of this total, 650,000 hp. is applied to lighting and heating, 1,300,000 hp. to industrial use, 50,000 hp. to traction purposes and 100,000 hp. to agricultural and other miscellaneous uses. Important individual projects are the Rhone development, which has the navigation and irrigation phases as well as its power features, the project for harnessing the hydro-electric forces of the river Dordogne involving seven generating plants, the world's largest dam at Chambon, and other miscellaneous projects such as those of the Rivers Ossau and Aspe.

Stack Height To Supply Draft Power

By H. MISOSTOW
Mechanical Engineer, Department of Health, Chicago, Ill.

THE latest boiler developments have greatly increased resistance to draft in the fuel bed and air passages. The stack, in addition to conveying gases, must act as a generator of power for operating the boiler. The connected load and mechanical efficiency are discussed.

FUEL-BED resistance of a few years ago was negligible compared to the present-day practice, where the rate of combustion of less than twenty pounds of coal per square foot of grate is considered low. Return-tubular or Scotch marine boilers with a large flue area, and water-tube boilers, crudely baffled, developed a horsepower on ten square feet of heating surface, and boiler resistance to the passage of flue gases was hardly of importance compared to the present-day practice with the baffling system of various water-tube boilers, developing a horsepower on five or six square feet of heating surface.

With negligible fire and boiler resistance, consideration of stack was of importance only as a means of conveying the gases out of the way and therefore the capacity was the only thing to be considered, but in modern practice the stack must not only convey the gases, but it must supply ample power to operate furnaces and boilers—in other words, to act also as a generator of power.

Stack Efficiency

A definite amount of power must be supplied, equaling, at least, that required to operate the boiler plant with the addition of stack loss. A stack is a fairly good generator, considering only mechanical efficiency, and can favorably compare to other generators or prime movers furnishing power. The mechanical efficiency as in engine practice is the ratio of power available to power generated, or brake horsepower divided by indicated horsepower; in case of the stack, draft available divided by draft due to height and temperature. A stack with an average temperature of 450 deg. F. gives available draft per foot height of 0.0053 in. and draft due to temperature and foot height is 0.0063 in.; then the mechanical efficiency of this particular stack is $0.0053 \div 0.0063 = 84$ per cent.

No sooner does a change take place in fire or boiler resistance due to constantly fluctuating condition of fire, quantity of gas, fire openings (fire too thick or thin, clean or dirty), or too much or too little air, than it is instantly indicated. Drop of draft over various resistances is constantly adjusting and readjusting itself so as to serve instantaneous changes of conditions. These changes are so rapid as to seem almost anticipating conditions that are causes. The most unusual thing is that the cause and effect are not separated by a measurable amount of time; the distribution of draft is at all times the very best that can be made to accommodate existing conditions, indicating that there is some immutable law of nature at work which is independent of time and free from error.

Draft readings every five minutes have been taken during three and a half hours, over the furnace, with the same fireman, load and stack. Thirty readings were taken and only one showed the drop over various parts so distributed as to give the maximum theoretical amount of useful work done by available draft, while twenty-nine fluctuated in such a way as to indicate constant effort to attain the perfect condition referred to. Repeated experiment in this study only confirmed the result of the first, except that it was brought out more strongly that changes are taking place constantly and five-minute readings are too far apart. The changes shown really indicate but a very small fraction of the changes that actually take place in draft distribution.

With regard to draft distribution: First, this is constantly changing in the boiler and over the fire to accommodate the constantly changing resistance of the fire and the boiler; secondly, changes are apparently governed by tendency to establish a balance of the draft drop over various resistances so as to obtain the maximum work out of available draft, and that at all times the work done is the maximum that could be obtained under the prevailing condition; thirdly, this is automatic and can be changed only by a change in the condition causing distribution.

Stack Loss Small

Draft pressure such as to overcome fuel-bed, boiler and breeching resistance, must be available to obtain satisfactory operating conditions; it is directly dependent on stack height, gas and temperature and outside temperature and indirectly on stack area, as far as comparatively small stack loss is concerned, which is subtracted from possible draft, making the available draft fluctuate inversely as the stack loss.

The stack should be primarily considered as a generator and secondly as a conveyer of gases; these two distinct functions should never be confused.

In purchasing a generator the first step, naturally, is to determine the connected load and then make an estimate of probable future requirements, and the sum of the two will be the required power of the generator. In much the same way the power required of the chimney is determined. Connected load to a stack in case of a power plant consists of the sum of the draft loss accruing in or over the breeching, turns, dampers throughout the boiler or boilers, fuel bed, grate bars proper, and that due to the passage of air through it to fuel bed usually considered as part of the fuel-bed resistance, except in a forced draft and high-resistance grate bar.

Study of the Connected Load

Taking in logical sequence, from stack to fuel bed, the first drop of draft occurs naturally, in the breeching. This is the connecting line between the boiler or boilers and the stack, and with its leads to boiler, damper and turns, deserves considerable attention in its design and construction; and in this case it is taken for granted that it has received due consideration, as draft loss will

largely depend on this point. In a well-designed and ample-sized breeching the loss is comparatively small and the loss per foot will be less than 0.0008 in. of water. The loss due to turns of a properly made breeching is not so great as it was in the old practice and hardly ever exceeds 0.025 in.; that in turns into boiler and damper loss does not exceed 0.05 in. of water. This is a rather generous allowance, particularly when the number of boilers exceeds three on the same breeching.

Draft Loss in Boiler

Draft loss in a boiler varies with the rate of operation. Requirements for the different types of boilers vary greatly, but for the same type the total draft requirement regardless of its fluctuation in distribution, is nearly uniform, and draft pressure sufficient to operate one at its maximum capacity may be taken as the requirement for that particular type of boiler. Required draft by different types of boilers varies from 65 to 40 per cent of that available at damper, the remaining 35 to 60 per cent being over the fire.

Besides the draft requirement of each type of boiler, the general baffling system may be of considerable importance in view of the universally known law, which asserts itself at times with disastrous results; that is, increase of gases in arithmetical ratio will require the increase of power used in geometric ratio. In one case the boiler, after reaching certain capacity, would stop steaming—one of the passages and turn was so restricted that as capacity reached the limit at this point, all draft would be used in overcoming the resistance at this turn and the fire would become heat bound—clinkers and glowing coke would gradually accumulate until practically no air could pass through the fire. The damper effect of the fuel-bed resistance would reduce the quantity of gas, and this naturally relieves the congestion at the restriction.

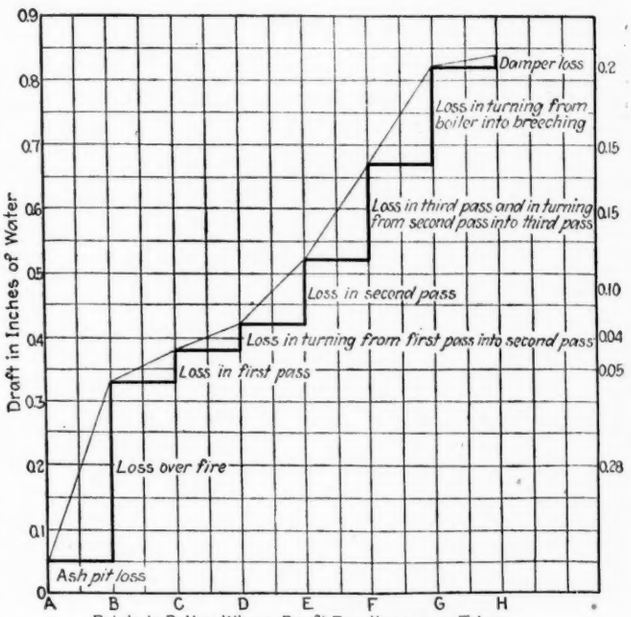
Reduction of gas quantity is the same as reducing heat available for steam-making purposes. There being very little loss in the boiler, all draft becomes available over the fire to work against fire resistance. Until things readjust themselves, there is not much steam generated. The fireman often terms this phenomenon "boiler lay down" or "fire choked," either of which sounds like a poor excuse; nevertheless, they are expressive of the fact in actual practice, and the condition is no fault of the fireman, as is often claimed.

The available percentage of draft over the fire or of drop in a boiler has been established for a large number of boilers, and now the purchaser can demand a curve showing draft distribution in a boiler at various rates of operation—the same as purchasers of motors or generators receive a characteristic curve at various loads. This would undoubtedly compel all boiler manufacturers to make a close study of baffling, which would result in advantage to both the manufacturer and the user.

Fuel-Bed Resistance

Fuel and grate-bar resistance must be overcome in order to have the desired amount of air pass through it to maintain the predetermined rate of combustion. The resistance of the fuel bed naturally varies with the shape and size of the fuel as well as the thickness of the fire and the condition of the fuel bed. For bituminous and semi-bituminous coal, ordinarily used for hand-firefurnaces in and around Chicago, and those of the same kind but rather inferior grades used in mechanical stokers, it is observed in practice that the resistance varies as the rate of combustion. About 0.01 in. of water draft per pound of coal burned per square foot of grate per hour, allowing ordinary variation in grade of fuel supplied, gives satisfactory results up to 25 lb. of coal per hour per square foot. Above this rating and in cases where fires are not self-cleaning, as in chain-grate furnaces, 0.005 in. of water draft should be added besides the 0.01 in. Fire and grate resistance expressed in inches of water, in practice then will be equal to 0.01 multiplied by the rate of combustion, or if the rate exceeds 25 lb. in a hand-fire furnace, the fuel-bed resistance on the average will be $0.01 \times 25 + (0.015 \times R - 25)$ = resistance of the fire in inches of water, where R is rate of combustion. It must be noted that this includes the velocity heat of air entering into the grates from the ashpit.

The draft-distribution curve given here is made from ordinary readings and of every-day character. Inter-



AVERAGE DRAFT DISTRIBUTION

sections of the horizontal and vertical lines give actual draft readings at the point taken. Vertical lines from points of one reading extending to intersect the horizontal line passing through the point of the preceding reading, is a draft drop between two points on same scale. The curved line between points is drawn on the assumption that all resistance between two given points is uniformly distributed. The loss in the second pass and in the turn into it is 0.1 and 0.04 in. of water, respectively, or 0.14, and in third pass and the turn into it, 0.15 in. of water, and this distribution of losses indicates that the passes are properly proportioned. In the turn from the boiler into the breeching, the loss is 0.15 in. of water, or four times as much as is used in making the turn inside the boilers, or at least 0.1 in. is wasted by restriction after gases have passed the absorbing surfaces and no useful work can be expected.

Available draft at boiler side of the damper is 0.82 in. of water; draft over fire, 0.33 in. of water; draft loss in boiler, $0.82 - 0.33 = 0.49$ in. Percentage of draft at damper available over fire will be $0.33 \div 0.82 = 0.4$, or 40 per cent. The percentage of draft loss in a boiler of the available draft on the damper will be $0.49 \div 0.82 = 0.6$,

or 60 per cent. These percentages will be about the same in other boilers of this type, and if the draft required in the boiler or over the fire is given, naturally the required total available draft at the damper can be determined. The draft over the fire, divided by 0.4 equals the total draft at the damper, or if the draft loss in the boiler is given, the total draft at the damper will be: Draft loss in boiler ÷ 0.6 = draft required at damper.

General Study of Connected Load

The preceding study of the connected load may convey the idea that this or that part of the chain is more important than others. For instance, it may be said that the draft drop over the fire is the most important as the primary object is to generate heat; or the delivery of hot gases to the absorbing surfaces is of greater importance than any other performance for, after all, fire is maintained only for the purpose of making steam; or breeching which takes away used up gases in order to make room for hot gases to make continuous operation possible. But none of these considerations is entirely right or wrong. The fact is, each link of the connected load is as important as any other and the plant performance will be no better than the best that can be expected at the weakest or poorest point. The well-known law applied to a common chain holds good in this case; that is, the strength of any chain is the strength of the weakest link. You may have a large furnace volume and plenty of air at the pressure desired, a good stoker and boiler, but undue restriction in the boiler or breeching will so modify the plant operation as to make very little use of the fine equipment beyond the point that restriction would allow. From the foregoing statement it should be clear that the stoker, boiler, breeching and stack must be so selected as to take care of one another at best maximum performance, otherwise partial failure will result.

Furnace volume is of importance to insure continuous ignition and flame travel to give time for flame propagation. Up to a critical point each is independently important; above the critical point it may be co-ordinate, and often one may be made to assist the others in their function to a degree that general performances may be improved.

Temperature reduction may assist to reduce the violence of distillation, making a reduction in the demand on furnace volume. Extra furnace volume may be used to obtain a turbulent mixture, reducing the time required for flame propagation and so on, but within the critical point each function is independent. This is true about the stack; that is, the area and height, when they are above the critical point, may be made to assist each other in performing their function, but below the critical point each is independent and important and any attempt of substitution of one by the other will result in failure of the stack performance. The "critical point" here used, means minimum requirements beyond which function will be arrested or interfered with.

Draft Requirements

Draft loss in well-designed breeching: (1) Breeching from nearest boiler to stack, lineal feet × 0.0008 = A''; (2) for each 90-deg. turn in breeching proper, and turn into stack × 0.05 = B''; (3) for uptake and damper for each boiler, number of boilers × 0.05 = C''. Total breeching loss = $A'' + B'' + C''$.

Boiler loss, as explained, is subject to variation. The following table, which was compiled by the Chicago Division of Smoke Abatement, from extensive draft readings in boilers under every-day service conditions, gives the draft loss in various makes of boilers in percentage of the draft available at the boiler side of the damper, as well as the draft that can be expected over the fire.

Name of Boiler	Draft Loss in Boiler: Percentage of Available Draft At Damper	Draft Available Over Fire: Percentage of Available Draft At Damper
Atlas	75	25
Atlas vertical	60	40
B. & W.	50	50
B. & W. Sewell baffle	65	35
B. & W. horizontal baffle	60	40
Bonus	65	35
Continental	65	35
Cahall	65	35
Erie City vertical	60	40
Erie City	60	40
Edge Moor, 4-pass	64	36
Edge Moor, Horizontal	60	40
Edge Moor, vertical	55	45
Hawkes	60	40
Heine	65	35
H. R. T.	47	53
Keeler vertical	51	49
Kroeschell Comb.	60	40
Lyons	60	40
Oil City vertical	60	40
Page	55	45
Stirling	65	35
Stirling, 4-pass	86	14
Sederholm	85	15
Wicks	58	42

Draft distribution in percentage of the draft available at boiler.

Draft required over fire: Rate of combustion required to obtain desired boiler horsepower × 0.01 = draft required in inches of water.

Draft loss in stack: For larger plants with modern stack, 0.0008 × h = draft loss in stack in inches of water; for smaller plants 0.001 × h = draft loss in stack; h equals stack height in feet.

Available draft per foot stack height: In larger plants usually operating above boiler rating, foot stack draft is 0.0055 in.; in plants operating at or below boiler rating, foot stack draft is 0.0053.

Draft available, as explained before, is subject to fluctuation, and what refers to Chicago will probably be correct for other places where the atmospheric pressure is about 14.7 lb. In general, the average draft per foot of stack will be the draft due to average stack and outside temperature at a given altitude less the stack loss per foot.

Conclusion

From the data outlined, there should be no difficulty in obtaining the stack height provided a starting point is first established. If the draft required by the boiler is known or the rate of combustion is given, the draft required at the damper may be found from the data given in the table, but one of these two points must be known in order to establish the starting point. Ascertain from local practice the probable number of pounds of coal required per boiler horsepower-hour. The maximum boiler horsepower desired times the number of pounds required to furnish the horsepower-hour, divided by number of square feet of grate area, will naturally give a rate of combustion and this will be a starting point; then the balance of the operation becomes a matter of simple arithmetic.

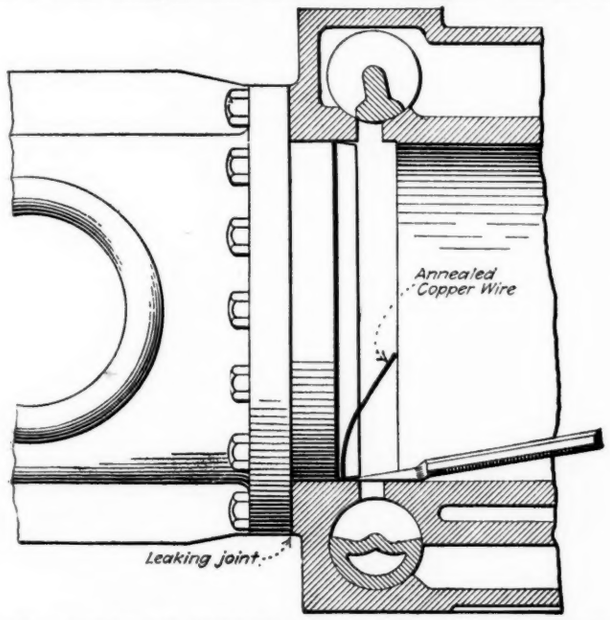
At the Pittsburgh station of the U. S. Bureau of Mines, J. D. Davis and J. F. Byrne have investigated the relative tendency of Pennsylvania coals to ignite spontaneously. The research consisted largely in the development of methods for the determination of the comparative sensitivity of coals to oxygen.

Calking a Leaky Cylinder-Head Joint

BY A. J. DIXON

The ground joint of the crank-end head on a 24x48-in. high-pressure cylinder of a compound engine had been leaking for a considerable time. The leak finally became so annoying that a means for stopping it had to be devised. It was first proposed to break the joint and insert a copper gasket, but this would have necessitated considerable labor, and the engine could not well be spared during the time required for the work, so it was decided to calk up the joint from inside the cylinder.

After the cylinder head and piston had been removed, the width of the space between the tapered part of the boss on the head and the wall of the cylinder was gaged by driving in a thin wooden wedge about 1 in. wide. From this templet a calking tool was forged on the end of a 1-in. octagon steel bar 5 ft. in length. The blade



TWO TURNS OF COPPER WIRE ARE CALKED AROUND THE TAPERED PART OF THE HEAD

of the tool was made about 1½ in. wide and the edge curved to a radius of 12 in.

A piece of copper wire, approximately 0.20 in. in diameter and of sufficient length to make two turns around the head was then annealed and calked in as indicated in the sketch. This proved effective in stopping the leak.

Cylinders of British Gas Engines

BY MAJOR TAYLOR-JOHNSON

A great deal depends on the proper design and construction of the cylinders of gas engines. Most of the failures with the older engines were traceable to faulty cylinder design. Until recently cylinders were cast in one piece with the water jacket and valve pockets, and this system is still favored by some engineers who claim that it is simple, strong and accessible. Fig. 1 shows a one-part cylinder as used by the Lilleshall Company, which has proved satisfactory. On the other hand, Galloway, who is another of the three British builders of large horizontal gas engines, uses a built-up cylinder of the form shown in Fig. 2. It will be seen that the main portion is in halves, each containing its own recesses for the valve chamber. These halves, which have flanged ends, are bolted up by means of these flanges between which an external projection on the liner is gripped after the cylinder castings have been forced over it by hydraulic pressure. The jacket casing covering the center portion is quite simple and has a rubber

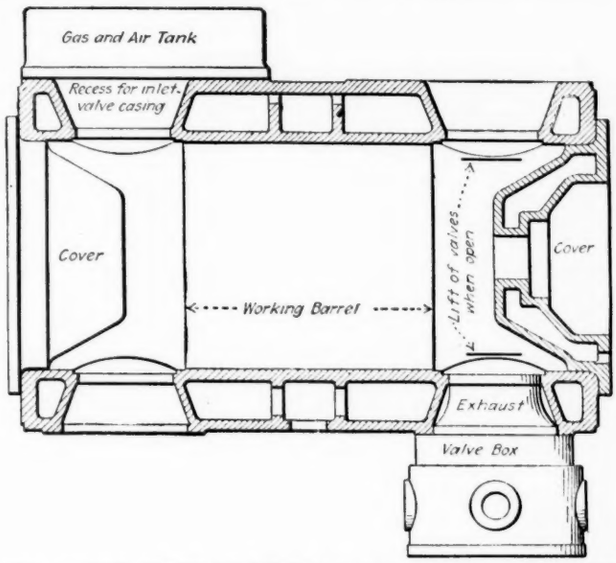


FIG. 1—ONE PIECE LILLESHALL GAS ENGINE CYLINDER

joint to allow for expansion. The main things to avoid in the design of these large cylinders are pockets, sharp corners and unsymmetrical design. While unsuitable material had no doubt had a good deal to do with cylinder failures in the past, these were mostly in the form of cracking. The cylinder covers are an important item in the construction of the whole, and it is no longer considered good practice to install the valves in the covers. The latter are now of quite simple design, fol-

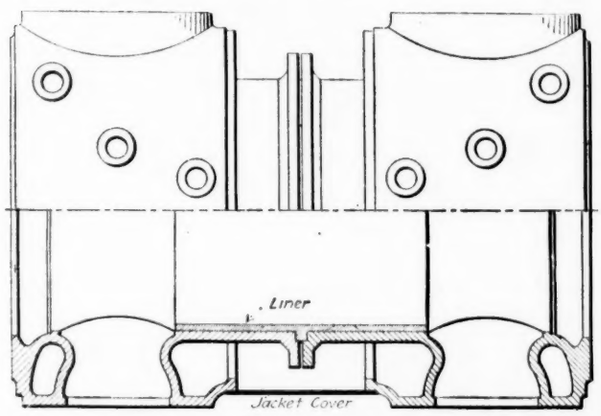


FIG. 2—GALLOWAY ENGINE CYLINDER WITH LINER

lowing the lines of those shown in Fig. 1, and having deep cooling spaces around the gland. These glands should be easy of access and be kept well forward, away from the cylinder.

Pistons have also given a good deal of trouble in the past, principally from cracking and overheating, and the evolution of a really satisfactory design is a welcome step forward. Pistons of both the one and the two piece designs have proved successful on modern engines.

The Overloaded Generator

Measure Capacity by Temperature, Take Advantage of Liberal Design, and Avoid Unsafe Conditions

By H. M. PHILLIPS
Electrical Aid, Public Works Department, Navy Yard, Washington, D. C.

MANUFACTURERS of electrical equipment adhere as a rule to the standard guarantees in regard to overload capacity. We have the so-called "maximum rated," or "50-degree," generator or motor which is specified to carry a momentary overload of 50 per cent, but which is not supposed to carry any overload for an appreciable length of time. There is also the "40-degree" generator, which guarantees an overload capacity of 25 per cent, to be carried for a specified time after the machine has attained a constant temperature at full load. In addition to these we have the maximum rated "duty-cycle" motors, which have no overload guarantee and will carry their full load for only a specified time; and the "40-degree" motor, which will carry full load for a limited period, frequently two hours, and a 25 per cent overload for a short time thereafter, 30 minutes being usually specified for the two-hour motor. Apparatus purchased of reputable manufacturers may be depended upon to meet their guarantees under normal conditions, and yet there is probably no manufacturer whose entire line of machines will greatly exceed their guaranteed capacity. There are, however, a very considerable number of ratings at which the "maximum rated" motor or generator is capable of carrying a considerable overload either continuously or for a limited period and at which the "40-degree" machine can carry more than its specified overload.

Utilizing Overload Capacity

In nearly all cases the machine may be operated with safety just below the point where the insulation is injured by the temperature to which it is subjected. Bare metal feels hotter than insulating material at the same temperature, and there is a similar though less marked difference in the "feel" of different kinds of insulating material. As a rule the temperature will be overestimated, which is better than underestimating, but does not give information regarding the exact possibilities of the machine. The smell of hot varnish is a warning that may come too late; the insulation is likely to be damaged even if there is not an immediate burnout. The thermometer, as applied to electrical apparatus, may be considered as laboratory or test-floor equipment, but the practical operating engineer can use it to advantage on many generators and motors that are compelled to carry overloads.

According to the Standardization Rules of the American Institute of Electrical Engineers, the insulating material ordinarily used is able to withstand a continuous temperature of 105 deg. C. (221 deg. F.) without serious deterioration; any higher temperature will injure the insulation, although there is not necessarily an immediate burnout. It is therefore essential that the temperature be kept below 105 deg. C. It is also assumed that a thermometer properly placed upon the external surface of a coil or winding will read 15 deg. C. lower than the actual temperature in the interior, which leaves 90 deg. C. (194 deg. F.) as the maximum allowable thermometer reading. The effect of any given load upon a generator or motor is not to produce a definite temperature in the windings, but to raise their temperature a definite amount above that of the surrounding air; with a uniform load the temperature becomes constant when this temperature difference is sufficient to carry off the heat at the same rate that it is being generated. It therefore follows that a machine will safely carry a heavier load upon a cool day than on a hot one, and that its ability to carry load depends to a very considerable extent upon its location in the plant and the circulation of air in its immediate vicinity.

Greater Overload Capacity When First Started

In order to establish a uniformity of rating under conditions approximating service conditions, it is assumed that the machine is not exposed to drafts, is in an enclosure large enough to allow unrestricted natural circulation and that the temperature of the surrounding air (the "ambient" temperature) is 40 deg. C. (104 F.). This gives a permissible temperature rise of 50 deg. C. (122 F.) and is the basis upon which the 50-degree motor is rated. Many engineers believe that the effects of temperature upon insulation are not as sharply defined as assumed by the "Standardization Rules"; that there is a slow deterioration at or below 105 deg. C. which tends to produce a short-lived motor, but that a temperature of 110 deg. C. (230 deg. F.) can be carried for short periods of overload without serious results. Retaining the other assumptions of the "Standardization Rules," this theory gives rise to the "40-degree motor," which the manufacturer guarantees to run with a temperature rise of 40 deg. C. on full load and to carry a 25 per cent overload for a limited time with a temperature rise not exceeding 55 deg. C. As the ordinary direct-current machine requires at least four hours' operation under full load to attain a constant temperature, it is obvious when one can carry a 25 per cent overload for two hours after reaching constant temperature, it can carry the same overload for a longer period starting cold; that the machine without overload guarantee can carry a considerable overload for a short period when first started; and that the important consideration under service conditions is not the temperature rise above the surrounding air, but the actual temperature attained by the insulation.

How and Where to Place Thermometers

The temperature of the machine should be measured with accuracy, for thermometers improperly placed give too low a reading. Thermometers should preferably be of the ordinary "chemical" type, a straight glass tube without guard and with graduations etched in the glass. Those having a bulb of the same diameter as the tube are to be preferred as being most easily applied to a flat surface. The graduations should be in centigrade degrees and need not read above 125 deg. For small machines thermometers about six inches long will be found convenient, and are comparatively inexpensive.

It is impossible to tell on the first test the hottest spot, so that a liberal supply is desirable. A dozen are sufficient for any test and leave a small margin for breakage. It is well to go over the hot machine with the hand before beginning a regular test if possible and locate the points that appear to have the highest temperatures, where the thermometer should then be placed when the test is made.

The thermometer should be secured to the stationary parts before starting and readings taken at regular intervals during the run. The maximum temperatures will not register, as there is generally a rise of several degrees after the machine is shut down, on account of a diminished air circulation and a more uniform temperature established between the inner and outer parts of the coil. They will, however, show when the temperature becomes constant, and on subsequent tests a correction may be added indicating maximum temperature. There is frequently a difference of several degrees in the temperature of the several coils of the shunt field, or between the two sides of the same coil; at least two thermometers should be placed on the field in position where it is believed that the maximum temperature will be found. If the field coils are taped, the bulbs of the thermometers may be inserted beneath the tape with good results. When this cannot be done, a piece of felt about $\frac{3}{8}$ in. thick and $1\frac{1}{2}$ in. square, placed on the thermometer bulb, in the desired position, can be held with thick shellac or glue, binding the whole securely with twine. An ordinary pill box, with cover removed and a notch cut in one edge the size of the thermometer tube, may be filled with waste and placed over the bulb, securing both the box and thermometer with twine.

Series Field Temperature Easily Measured

Some small machines have the series coil wound directly on top of the shunt and the two taped up as one coil; in such cases the interior of the shunt coil is likely to be more than 15 deg. C. above the thermometer reading which should be kept 10 or 15 deg. C. below what would otherwise be allowed; when practicable it is preferable to take the temperature of the shunt field by the resistance method and allow 5 deg. C. more rise than when taking a thermometer reading. For series field and interpole windings the thermometer bulb may sometimes be introduced in some small cavity between turns and packed with a small quantity of waste; when this cannot be done felt or a pill box may be used.

Much useful information may be obtained by placing a thermometer as near as possible to the center part of the armature where it emerges from one of the poles of the main field. The most convenient arrangement is a piece of fiber tubing of a length suited to the size of the machine and of just sufficient diameter to let the thermometer slide freely through it. The thermometer should then be provided with a string and stop which will permit only the bulb to extend beyond the end of the fiber tube. The tube may then be secured firmly in such a manner as to bring the bulb in the desired position; it is well worth while to arrange the holding device so that it may be either left in position for an indefinite period or replaced in exactly the same position when desired. This thermometer will generally be found to read within 10 or 15 deg. C. of a reading obtained on the armature coils after the machine is shut down; when its reading becomes constant, it shows that the temperature of the armature is also constant; after one or two comparisons of its readings with the actual temperature of the armature, fairly close approximations of the armature temperature may be obtained without shutting down.

Although the temperature of the surrounding air (the ambient temperature) might be disregarded in some tests, the actual temperature obtained on the windings determining the safety of the machine at any given time, it should always be recorded as it is valuable in determining the safe load under other weather conditions; and if the test is conducted at rated load, it enables one to check the manufacturer's guarantee. As a rule two or more thermometers should be placed at about the same level as the shaft and about four feet from the machine in locations where they will not be much influenced by purely local conditions that do not actually affect the temperature of the machine itself. For example, a false reading may be obtained by hanging a thermometer where it will be struck by a current of hot air coming out of the armature, or in too close proximity to a steam pipe or other hot body which is not of sufficient size to affect perceptibly the temperature of the machine itself. On the other hand, if external objects do actually affect the temperature of the machine, false readings may result from attempting to avoid them. Where such conditions exist, it is advisable to use several thermometers and average their readings. If there is considerable fluctuation in the air temperature, the thermometers may be placed in small cups or cans of oil and more uniform readings obtained. When a check on the manufacturer's guarantee is desired, the machine should be protected as completely as possible from drafts; otherwise actual service conditions should be maintained with thermometers to windward if there is air circulation.

Shutdown to Obtain Maximum Readings

The generator or motor should be shut down while it is at its maximum temperature, or if this is impracticable, at as high a temperature as possible with a careful notation of the amount that the stationary thermometers have fallen from their maximum readings; and therefore placed upon the armature and commutator as quickly as possible. The commutator temperature is best obtained by the use of a piece of putty just large enough to cover the thermometer bulb, with a small piece of waste pressed down on top of the putty. A thermometer should be placed as far into the winding as possible at each end of the armature and sufficient waste used to cover the bulb and prevent air circulation in the immediate vicinity. On large machines a thermometer should also be placed on the armature iron, midway between the ends, and covered with waste, although the temperature so obtained is rarely as high as that at the ends. Immediately after placing these thermometers, or even before, readings should be taken on the stationary thermometers; which sometimes rise quite rapidly immediately after shutting down and then begin to fall almost as rapidly. Readings should then be taken with sufficient frequency to record the maximum temperature.

Using Capacity Where Best Suited

A number of very practical results may be derived from a test of the nature described. A generator that has no guarantee of overload capacity (a maximum-rated or 50-degree generator) may run at considerably less than rated capacity until the lighting load comes on, when it may have to carry an overload ranging up

to 30 per cent for an hour or more; is it safe to operate under these conditions? The manufacturer will probably say that it is not and disclaim all responsibility, but the engineer may trust to his thermometers with a very fair degree of safety. If a previous test at approximately full-load, constant-temperature conditions shows that the stationary parts equipped with thermometers rise 5 deg. C. after the machine is shut down and that the thermometer near the armature surface is 10 deg. C. below the temperature obtained on the armature itself, the engineer may run with considerable confidence until the former shows a temperature of 85 deg. C. and the latter 80 deg. C. The difference between the running and shut-down temperature is likely to increase with heavier loads, so it may be well to allow a margin of safety of three or four degrees. On the other hand, no serious consequences should ensue if the same temperatures are allowed as on the "40-degree" motor, a maximum of 95 deg. C. (203 deg. F.) by thermometer after shutdown should be the limit.

Check Armature Temperatures

If it is possible to do so, the engineer should verify the foregoing assumptions by shutting down while at maximum temperature and taking readings. Even though no previous test has been made, it should be safe to run until the thermometers on the stationary parts reach 80 deg. C. (176 deg. F.) or that one near the armature surface 70 deg. C. (158 deg. F.). If it is found that the ambient temperature of the engine room is 30 deg. C. (86 deg. F.), he can reasonably expect to carry a small overload. A very rough approximation of the amount may be made as follows: If the machine is maximum rated, its capacity rating is based upon a rise of 50 deg. C. above an ambient temperature of 40 deg. C. (104 deg. F.); with an ambient temperature of 30 deg. C. the rise may be increased to 60 deg. C., or 20 per cent, under which condition it may be assumed that the amount of heat liberated by the various parts of the machine will also be increased by 20 per cent. The heat generated in the armature coils and series windings varies as the square of the current; neglecting all other factors, the load may then be increased in the proportion of $\sqrt{100}$ to $\sqrt{120}$, which is 10 to 10.95, practically 10 per cent; for such temperature differences as are likely to be encountered, the percentage of load increase may be taken as one-half the percentage of temperature increase allowed.

Greater Overload Capacity in Cooler Weather

The fact that the shunt field losses, iron losses, friction and windage, which remain practically constant and may be as high as 50 per cent of the total losses, are not included in the foregoing calculation gives a considerable margin of safety; on the other hand, the temperature rise is by no means uniform throughout the machine and these losses may have very little effect upon the temperature of the hottest part, which may be even hotter than appears from the thermometer readings; the assumptions made in the calculation may therefore be taken as a fairly close approximation to actual conditions. If a test made during the summer shows that a small overhead can be safely carried, it is certain that the lower temperature of winter weather will permit a heavier overload, which may be just what is needed to provide for the increased lighting load.

A motor with a one-hour rating is frequently purchased for driving a machine tool. In actual practice the motor will probably run continuously, or with very brief shutdowns, for several hours; part of the time with very light loads and very probably with occasional overloads. The thermometers will show whether or not the motor is actually overloaded. Tests conducted during the cold weather may show that a motor driving an important piece of equipment is loaded pretty well up to the safe limit; the engineer can predict with considerable confidence that with the same load it will not survive the hot weather and save himself considerable tribulation by making preparations accordingly. In some cases the motor may be saved by providing better ventilation—forced ventilation if need be. The generator or motor may be doing very well with a load that carries the temperature 5 or 10 deg. C. above the safe limit; but it is an exceedingly optimistic engineer that can hope to keep up this gait indefinitely; it is not impossible, but exceedingly improbable. The owner or manager is inclined to be optimistic, at any rate not inclined to spend money for new equipment while the old is apparently able to do the work efficiently. With positive data obtained from thermometer tests the engineer has a better chance of convincing him that it is poor policy to wait for the inevitable burnout, with consequent delay and the necessity of making expensive repairs.

When operating on the strength of previous tests, the engineer should be on his guard against changed conditions in regard to air circulation and ambient temperature. A very slight change in direction of air circulation may bring hot air to his machine in place of cool, or the introduction of additional steam pipes or apparatus throwing off a considerable volume of hot air; a very slight draft may take this safety away, but if the draft is lacking or renewed, the hot air may be drawn back to the machine with a considerable increase of temperature as a consequence.

Damage by Excessive Overload Not Indicated

There are exceptions to all rules; absolute safety cannot be insured by keeping the temperatures down to what is acknowledged to be a safe limit; and it is also necessary to use a certain amount of judgment in connection with the results obtained by thermometers. In some cases it is practically impossible to place a thermometer so that it will read within 15 deg. C. of the actual temperature of the hottest spot in the winding. A very heavy overload, say in excess of 50 per cent, may cause such a rapid rise of temperature in the interior that the damage is done before it can be detected by a thermometer on the surface. Motors with a 15-minute or 30-minute rating are for practical purposes heavily overloaded. Continuous-duty motors of a lower rating may not be safe to carry much overload in such cases; although the thermometer may be used with considerable faith to demonstrate their ability to carry the same or a smaller load for a longer period of time. If the machine is poorly insulated, or if the insulation has been damaged by previous abuse, there is the likelihood of a burnout at any time, and the danger may be increased by the mechanical stresses due to an overload or by an increase in temperature that would have no effect whatever upon a machine in good condition. It will add considerably to the prestige and peace of mind of the engineer if he can reduce these chances to a minimum by gaging the capacity of his machines with a moderate degree of certainty. This at least can be done by the intelligent use of thermometers.

Corrosion—Apparatus To Prevent It*—I

THE article "Corrosion—Its Cause and Cure," in the October 3 issue, showed that practically all corrosion troubles are due to one thing—dissolved oxygen. The same article described the Kestner apparatus as used in Europe for oxygen removal. Several types of apparatus for preventing corrosion are used in this country. Some of these are described in the present article and others in its sequel. In every case the object is accomplished by removing the dissolved oxygen either with or without the other gases.

BEFORE proceeding to study the various American types of apparatus used for preventing corrosion in the power plant, we will review briefly the points brought out in the first part of the preceding article. While, in the theoretical sense, there may be some difference of opinion as to the cause of corrosion, the practical man will not go far wrong if he assumes that the chief cause is dissolved oxygen. The average water supply, if freed from oxygen, will cause practically no corrosion.

There are two general methods of removing the oxygen. One is to allow it to use itself up on a mass of scrap or low-priced iron or steel. This method is exemplified in Europe by the Kestner degasser, described in the previous article. The Speller process in this country is based on the same general principle, although differing considerably in design and method of operation. This will be described later in the present article.

A fundamentally different method is to remove all the gases, including oxygen, by reducing the partial gas pressure and increasing the water temperature. Suppose two open tanks or pans are placed side by side, and that one is filled with gas-free water, while the other is filled with water containing an excess of dissolved air. If, after waiting a number of hours, a sample is taken from each pan, it will be found that each contains practically the same amount of oxygen and nitrogen in solution. In other words, the water, originally free from gas, has absorbed air, and that with an excess has given up some. The solubility of gases in water follows "Henry's Law," which states that when a given weight of water at a given temperature is exposed to a mixture of gases, it will absorb a definite amount of each, and that the amount of any given gas absorbed is in proportion to its partial pressure (the pressure it would have if the other gases were removed), without regard to the presence of other gases or vapors.

Even for a constant partial pressure the solubility of gases in water drops off somewhat as the temperature increases. For this reason the mere heating of water tends to drive out the gases. But there is another factor that is much more important. This is a reduction of the partial pressure of the gases. The vapor pressure increases with the temperature, but the total pressure (when water is heated in an open tank) remains constant around that of the atmosphere, 30 in. of mercury absolute. So the air pressure must be the difference between 30 in. and the vapor pressure for the given temperature. When water reaches the boiling point, the partial air pressure becomes practically zero, so that practically all the air separates out, assuming that provision is made to disengage the entrained gas bubbles in the time allowed. Therefore, an ordinary open feed-water heater removes most of the dissolved gases if it heats the feed water up close to 212 deg. and has sufficient disengaging surface for the bubbles. It does not ordinarily effect a complete separation.

In some of the modern power plants with electrically driven auxiliaries it is desirable, from the point of view of heat balance, to have the water enter the economizer at temperatures as low as 140 deg. F. At such temperatures the ordinary open heater cannot remove the air effectively, so that the corrosion of the economizers may become a serious problem, particularly if they are of the steel-tube type. Aside from the corrosion due to the dissolved oxygen, there are several disadvantages of any dissolved gases, whether corrosive or not. These tend to air-bind the tubes of the surface condenser and other heat-transfer apparatus. In the case of surface condensers the vacuum is reduced not only by the resulting increased temperature difference between the cooling water and the exhaust, but also by the fact that the pressure of air elevates the absolute pressure of the exhaust above that corresponding to the exhaust temperature. These effects, however, are generally considered of much less importance than the corrosion caused by the dissolved oxygen. An apparatus particularly designed to secure a high degree of gas separation at temperatures well below 212 is shown in Figs. 1, 2 and 3. This operates upon the principle of "explosive boiling." If water under atmospheric pressure is heated up practically to 212 deg. (the boiling point at this pressure) and then sprayed into a space under a partial vacuum, some of it instantaneously flashes into vapor because the temperature of the entering hot water is above the boiling point at the lowered pressure. Suppose, for example, that one pound of water at 212 deg. and atmospheric pressure (30 in. barometer) is sprayed into a space where the vacuum is 11 in. of mercury. The absolute pressure in the space is 30 — 11 = 19 in. of mercury, and the boiling point at this pressure is 190 deg. Therefore the temperature cannot remain above 190 deg. as long as any water is present. In falling 212 — 190 = 22 deg. the water gives up 22 B.t.u., which must go to evaporate some of the water. The amount of heat required to evaporate one pound of water at an absolute pressure of 19 in. of mercury is 984 B.t.u. Therefore 22 B.t.u. will evaporate $\frac{22}{984}$ = 0.0224 lb. or 2.24 per cent, by weight, of the water.

Although only 2.24 per cent by *weight*, the *volume* of this vapor, under the given conditions, will be about fifty-five times that of the water entering the separator. In its violent formation throughout the mass of the water, the vapor carries with it practically all the dissolved gases, consisting chiefly of the oxygen and nitrogen of dissolved air.

The operation of the deaërator installation shown diagrammatically in Fig. 1 is as follows: The water to be treated passes first through the small surface

*The following articles have so far appeared in the series on feed-water treatment: "Softening Boiler Feed Water with Zeolites," Sept. 12, 1922; "Evaporators in the Stationary Power Plant," Sept. 19; "Corrosion—Its Cause and Cure," Oct. 3.

condenser and is heated by the exhaust vapor from the separator ejector. It then goes to an open heater where its temperature is raised to practically 212 deg. by exhaust steam from engines or turbines. The resulting hot water next passes to the "separator" in which a

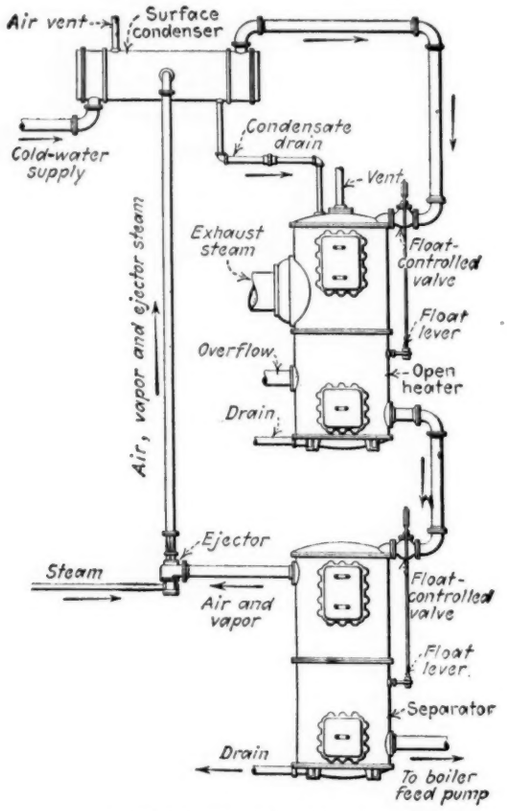


FIG. 1 —ELLIOTT DEAERATING INSTALLATION

vacuum around 11 in. is maintained. Here part of the water boils explosively, the dissolved gases being liberated with the vapor.

Constant water levels are maintained in the open heater and separator by float-controlled valves on the admission lines. The gas-free water passes from the bottom of the separator to the boiler-feed pump, while the mixture of gas and vapor is drawn off by a steam ejector which also serves to maintain the necessary vacuum. From this the gases and vapor, together with the ejector steam, pass into the condenser previously mentioned. There the vapor condenses, returning its heat to the incoming feed water, after which the condensate gravitates to the heater, while the gases pass off through the vent with those released in the heater.

It is evident that the only heat losses in this system, aside from radiation, are those represented by the venting from the small condenser and the open heater. The heat in the vapor resulting from the explosive boiling, as well as that in the steam supplied to operate the ejector, is recovered in the condenser. There is, however, a small "availability" loss due to the fact that the boiler-feed temperature is about 25 deg. below that of the exhaust steam.

A clearer idea of what takes place within the separator may be obtained from Fig. 2, which is a cross-section of a separator of the horizontal-shell type. It will be noted that the spray valve is spring-loaded so that the opening of the spray nozzle varies with the rate of feed. The latter, in turn, is controlled by a float to maintain a constant water level. After the explosive boiling, which occurs as it leaves the spray nozzle, the water runs back and forth over the agitating pans which insure the release of any entrained air. The released air, together with the vapor produced, is continually drawn off to the ejector.

Fig. 3 is a shop photograph of a deaërator of the horizontal-shell type, built for the Los Angeles Gas and Electric Co. The apparatus shown has a water-handling capacity of 250,000 lb. per hour when operating with an open-heater temperature of 210 deg. and a separator temperature of 188 deg. Under these conditions the guaranteed maximum dissolved oxygen in the treated water is 0.2 cubic centimeter per liter.[1]

How the Deactivator Works

The preceding article described the Kestner Process for removing oxygen from feed water by passing it through a bed of steel turnings, which, in rusting, take up most of the dissolved oxygen. The same principle of allowing the water to "wear out" its corrosive properties on low-priced metal instead of on the much more expensive metal of piping, economizers and boilers, is embodied in the "Type B Deactivator"[2] of the Anti-Corrosion Company.

Fig. 4 shows the deactivator proper and its immediate connections. It consists of a solid-steel tank

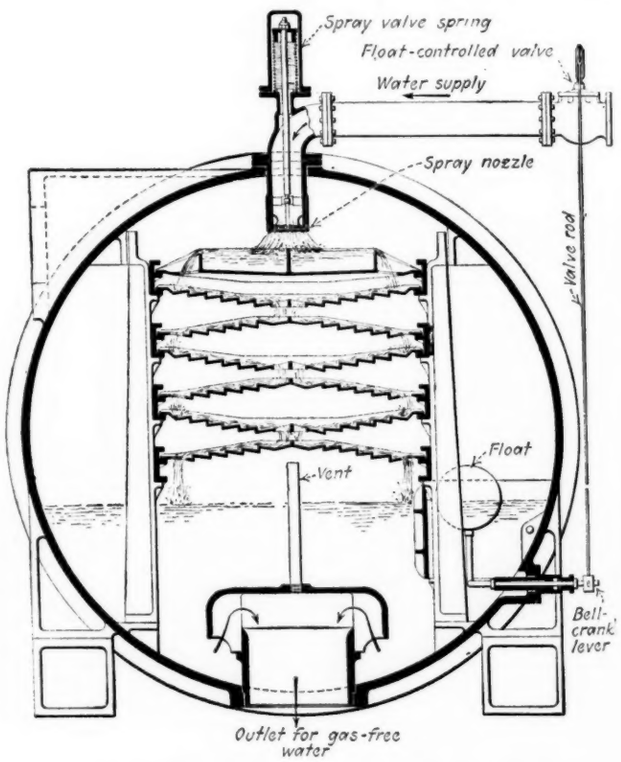


FIG. 2 — CROSS-SECTION OF HORIZONTAL-SHELL DEAERATOR OPERATING ON THE PRINCIPLE OF EXPLOSIVE BOILING

having connections, manholes, etc., as shown. The deactivating material is in the form of special per-

[1] It is the general custom to express dissolved oxygen as so many "cubic centimeters per liter" of water. Unfamiliarity with the metric system need cause no confusion here if it is remembered that one cubic centimeter per liter is the same as one part per thousand by volume. This is so because one liter is equal to one thousand cubic centimeters.

[2] The distinction between a deactivator and a deaërator is that the former removes only the corrosive gas (oxygen), while the latter removes all gases including oxygen.

forated steel sheets with integral projections to give proper spacing and circulation when they are stacked up in the manner shown. The bottom sheet is held several inches above the bottom of the tank by pipe supports to provide a settling space in which the rust can collect to be blown off from time to time. A sill and hood are provided on the outlet connection so that but little of the rust is carried over to the boilers. The small amount carried over is in a fine colloidal form and remains in suspension until it reaches the mud drum, from which it can be removed by blowing down once in two or three months.

The baffling in the tank prevents short-circuiting of the water and forces it to come in contact with all the deactivating metal. The rate at which water passes through the tank determines the time of contact and is regulated to secure satisfactory removal of the oxygen.

This type of apparatus is ordinarily used in connection with an open or closed type of feed-water heater which heats the water nearly to 212 deg. before it enters the deactivator. The higher the temperature, the more rapid is the action of the deactivating material and the smaller can be the apparatus for a given output. Where the feed temperature is below 200 deg. it is ordinarily more economical, from the viewpoint of investment, to use a combination of deaërator and deactivator such as will be described later.

It frequently happens, however, that a feed temperature normally below 200 deg. on account of insufficient

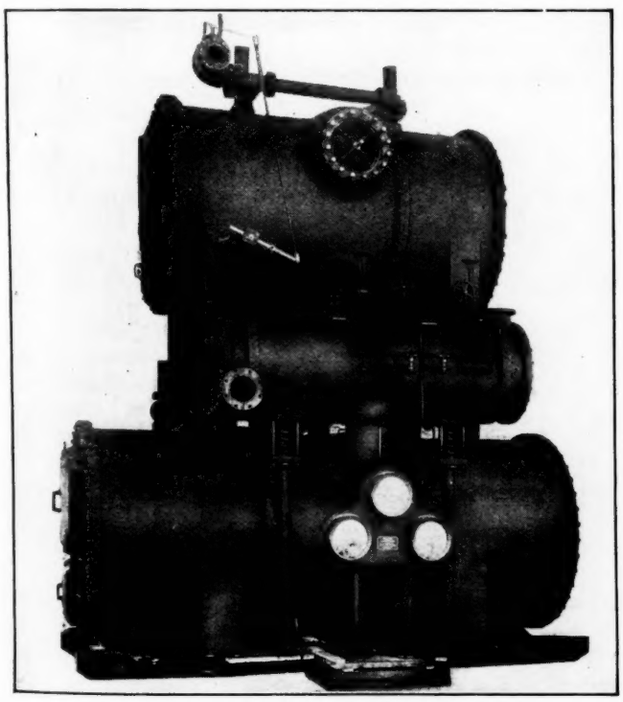


FIG. 3—INSTALLATION OF APPARATUS SIMILAR TO THAT SHOWN IN FIGS. 1 AND 2

exhaust steam can be raised above 200 by making use of supplementary live steam. This involves no actual loss of heat since the heat in the live steam is returned to the feed water Where economizers are used, the higher feed temperature would be a disadvantage, so this arrangement would not ordinarily be used in such cases.

In some cases it is desirable to provide storage for deactivated water to take care of surges in the system. Fig. 5 shows an arrangement of the B Type Activator with storage facilities. With this arrangement the water passes from the deactivators to the storage tank through the two connections *A* and *B*. The valve in connection *A* is regulated by hand for the average load. Connection *B* is provided with a balanced valve *C* operated by the float control *D*. This water-line governor arrangement brings the connection *B* into service whenever the water level in the storage tank drops to a

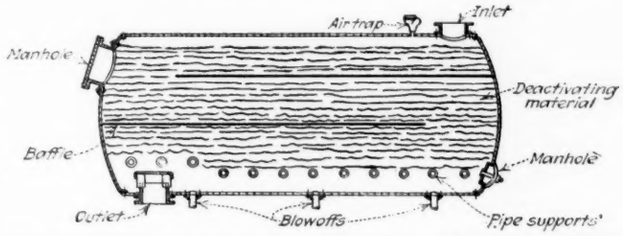


FIG. 4—CROSS-SECTION OF ANTI-CORROSION CO. TYPE B DEACTIVATOR

certain point. In this way the water level in the storage tank can vary and thus afford the desired storage capacity. The action of the water-line governor prevents this storage from falling below a certain minimum and always keeps a supply of the deactivated water ahead of the feed pumps.

In order to prevent the deactivated water from picking up some more air, a large equalizing connection *G* is provided between the storage tank and the supply of exhaust steam to the feed-water heater. This allows steam to take the place of the water in the tank as the level falls.

The water passes out of the storage tank to the boiler-feed pumps through the outlet *E*, which has a mud sill and hood like that in the deactivator, so that the storage tank acts as an additional settling chamber. A valved bypass *F* is provided around the storage tank.

Combination of Deaerator and Deactivator Used at Low Temperatures

Fig. 6 shows a deaërating type of deactivator intended for use where large volumes of water are to be treated under varying temperatures, usually from 100 to 200 deg. F., for the removal of the dissolved gases. It will be remembered that the apparatus previously described was designed to remove only the oxygen, which is the corrosive element. The apparatus shown in Fig. 6 is designed to remove not only the oxygen but also the greater part of the other gases. There is a certain advantage in removing the non-corrosive gases in that it results in increased heat transfer in boilers, condensers and similar apparatus.

This type of apparatus is particularly applicable to the treatment of feed water for steam boilers where the normal operating temperature of the water to be treated is not high enough to allow it to be economically handled in a simple deactivating apparatus such as that just described.

Referring to Fig. 6, the arrangement shown is for use in connection with the deactivation of feed water where an open feed-water heater is to be used. A closed feed-water heater or other means of heating the water to be deactivated may be substituted for the open heater with certain slight modifications in the layout.

In the arrangement shown, the feed water is brought to the open heater in the usual way and is generally controlled by a water-line governor and regulating

valve, as indicated. Instead of the open heater being vented to the atmosphere in order to free it of the gases, it is vented through pipes 1, 2 and 3, into pipe 4, and into the deactivator through perforated pipes 5 and 6. All the steam that passes over with these gases is condensed by mingling with the water entering the deactivator. This prevents the loss of steam to the atmosphere that would occur if the heater were vented in the usual manner.

Pipe 14 acts as an automatic emergency vent whenever the deactivator is shut down or the vacuum fails. A low-range vacuum governor is located in line 4 for preventing anything more than a slight vacuum being carried on the feed-water heater, so as to avoid an excess of steam being carried over from the open heater to the deactivator. After leaving the feed-water heater through pipe 7, the water passes either to the deactivator through pipe 8, or directly to the boiler-feed pumps through pipes 9 and 10, as conditions may require. A stop valve is located in pipe 9 for bypassing the water directly to the feed pump at any desired time.

The water, in flowing to the deactivator, passes through a differential vacuum governor chamber which, together with the governor in the vacuum line leading to the deactivator, automatically maintains the vacuum in the deactivator at a point slightly below the boiling pressure corresponding to the temperature of the entering water. There is not space here to describe this governor, except to say that it depends for its action upon a "sylphon" filled with a special volatile liquid.

From the inlet pipe the water passes to the distributing pan 11, from which it flows to pans 12 and 13, over the perforated pipes 5 and 6. As a result of the water being cataracted over a series of pans and thus being broken up into small particles under a vacuum practically corresponding to the boiling point of the water, the major portion of the dissolved air and other noncondensible vapors is removed. This process usually removes the dissolved oxygen down to about 0.75 cubic centimeter per liter. To still further reduce the dissolved oxygen, the water after leaving the deaërating process, is passed through a thick mass of deactivating material consisting of ten perforated sheets of specially prepared metal located in the lower section of the deactivator.

In certain cases where the volume of water handled, or temperature conditions, make it impractical to remove the residual oxygen by means of these metal plates, a chemical treatment is substituted for the metal, or added to the deactivating system. It will be noted that the deactivator is provided with a shut-off valve for use in case of emergency and that the whole apparatus is automatic in its operation. In cases where headroom will not permit of the arrangement shown, the heater may be placed nearer the level of the deactivator provided special arrangements are made to allow the vacuum to draw the water from the heater to the deactivator. This arrangement, however, should be avoided if possible. Usually, a space of from 3 to 6 ft. is required between the bottom of the deactivator and the feed-pump section.

The vacuum required for the operation of the system is ordinarily produced by a regular vacuum pump wherever condensers are used. No increase in the usual capacity of the dry vacuum pump is required since the air removed in the deactivator does not again have to be removed in the condensers. The required vacuum may, of course, be produced by a steam-jet ejector or a separate vacuum pump wherever other vacuum-producing means are not available.

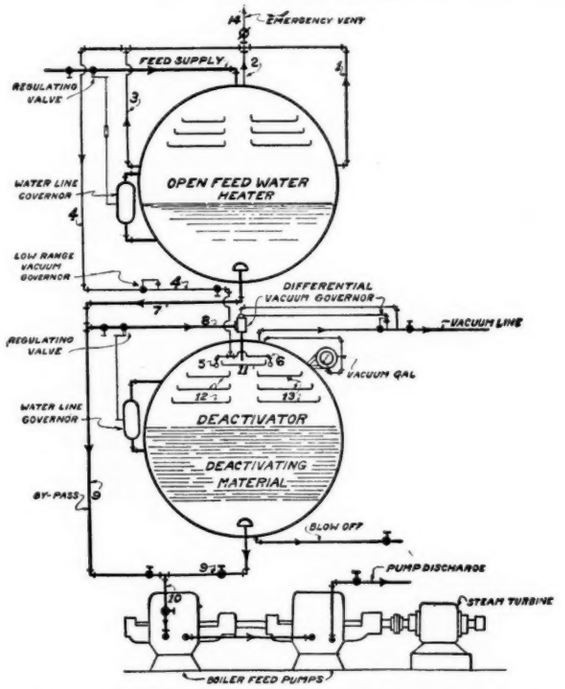


FIG. 6—SYSTEM COMBINING DEAERATION AND DEACTIVATION

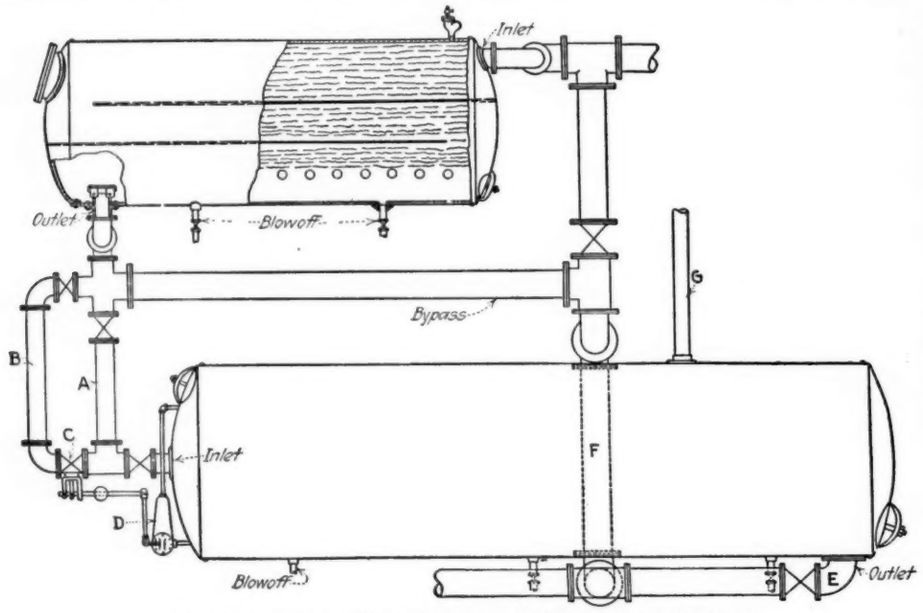


FIG. 5—TYPE B INSTALLATION WITH STORAGE TANK

Diagnosing Ammonia Compressor Troubles

By T. M. GUNN

A Discussion of the Use of Thermometers To Detect Compressor Defects — Proper Suction and Discharge Conditions — Chart Showing Correct Discharge Temperature for Any Suction Pressure

WHEN a doctor examines a patient, the first thing he does is to put a thermometer under the sick man's tongue. He may also count the pulse, listen to the action of the heart and lungs, measure the blood pressure and perform many other tests, but the thermometer comes first. When a practice is so general among all physicians, it has a good reason, and in this case it is because the thermometer shows seriou conditions more promptly than other tests.

The ammonia compressor in a refrigerating plant is almost human in its similarity. A thermometer on the compressor discharge is worth many times its weight in gold. There is a temperature of discharge gas that is right. If the temperature is more than it should be, the compressor, like a feverish human body, is wasting energy rapidly. If the discharge gases are colder than the normal temperature, the compressor may be in danger of losing its cylinder head, unless it is specially constructed, when it may be compared to a frog, which can stand a severe chill without any danger to its health.

A THERMOMETER IS WORTH ITS WEIGHT IN GOLD

Too Much or Too Little Superheat May Cause Trouble

In tracing the cause of the fever or chill from which the compressor may be suffering, just as the doctor examines the patient's diet, so the engineer examines the suction gas. Again a thermometer is needed. Too much superheat in the suction, like too much hot soup to the patient, may cause the high temperature; or a chilled condition may be the result of too much liquid ammonia in the suction, which may be compared to too many cold drinks.

The patient's serious condition may come from other causes than an improper diet. One of the most serious conditions would be the improper action of the valves of the heart. The doctor tests this by sound. So does the engineer. Listening to the action of the compressor, he detects an unusual click or a missing click and a hissing sound, and often determines its location and cause before shutting down to correct the trouble.

Let us be thankful that an ammonia compressor can be shut down and the ammonia pumped out. If repairs had to be made, as with the human system, on the operating table, with the machine still running, and if the machine once stopped were stopped forever, the engineer certainly would have his hands full.

The right temperature for the human body is a fairly fixed figure, so that it is a simple matter to learn if the patient is feverish. The ammonia compressor presents a little more complication in this regard. Each condition of operation has a correct temperature for the discharge gas. Possibly there are many cases when this fact has resulted in calling a "doctor of refrigeration" from outside, when it should have been possible for the operating engineer to locate the trouble. More often, the difficulties in the way of diagnosing compressor troubles have resulted in the long continuation of an unknown loss, like a chronic disease, which eats into profits and brings disrepute to plant and operator.

The following explanation and accompanying diagram are intended to clarify some of the mysteries regarding the use of temperatures in analyzing operating conditions of an ammonia compressor, and to avoid the necessity of making calculations.

The temperature of the ammonia gas discharge from a compressor depends on several things, including head pressure (condenser pressure) and back pressure, condition of entering suction gas, whether wet, dry or superheated, and the degree of perfection with which the piston and valves operate.

Suction Gas Should Be Regulated

The condition of the suction gas can be regulated and should be kept right. For regulating this, the thermometer on the suction is very useful. The temperature in the evaporating coils is found from ammonia tables (or from the chart, as will be explained a little later). Generally, the thermometer on the suction shows a higher temperature than this for the evaporating coils. The temperature difference is the suction superheat. Much suction superheat causes inefficient operation. A little superheat is the safest condition, since this means that all the suction vapor is dry and carries no ammonia liquid.

IF THE GAS IS COLD THE COMPRESSOR MAY LOSE ITS HEAD

The thermometer on the suction may show the same temperature as that in the evaporating coils. This shows that there is no superheat in the gas returning to the compressor, but it does not tell whether there is liquid coming back with the vapor or whether the vapor is dry. Since there is no way to know this easily, it is a little dangerous to operate with such a low suction temperature, because, without knowing it, the amount of liquid might become so great as to cause danger of damaging the compressor. Otherwise, a little liquid in the suction gas is not harmful.

As a normal condition, assume that the suction gas is dry and saturated; that is, it carries no liquid and is not superheated. The accompanying chart is based on suction gas in this condition. It also assumes that the piston is tight and that the valves operate perfectly, without resistance to the movements of the gas.

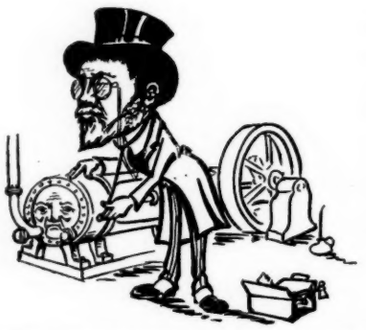
The purpose of the chart is principally to show what the normal temperature of the discharge gas would be for a perfect compressor operating under the conditions just described. Incidentally, it shows condenser and evaporating coil temperatures, without reference to the ammonia tables.

The bottom scale is for back pressure, as read from a correct gage, and the scale at the top reads the corresponding temperature in the evaporating coils. The scale at the left is for head pressure, also as read from the gage, and the scale at the right shows the corresponding condensing temperature. Diagonally across the face of the chart is a family of lines, or contours, for the temperature of gas discharged by the compressor. As an example of the use of the chart, suppose the back pressure to be 21 lb. gage. On the scale at the bottom of the chart find the point for 21 lb., which has been marked *A*. From this point trace a vertical line *AB* to the scale at the top of the chart, where the temperature corresponding to a gage pressure of 21 lb. will be found at the point *B* to be between 6 and 7 deg. F. and should be read 6.8 deg. F.

SUCTION SUPERHEAT, LIKE HOT SOUP, MAY CAUSE A HIGH TEMPERATURE

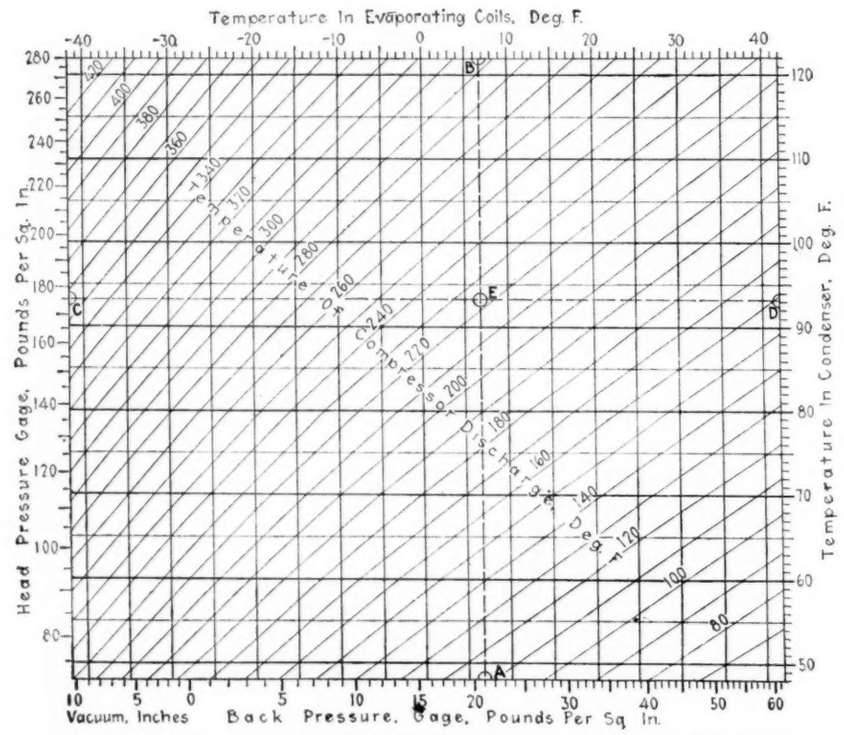
Next, on the scale at the left, find the point *C* representing 175 lb. gage, and from it trace the line *CD* to the scale at the right, where the temperature of condensation corresponding to that pressure can be read at *D* as 93.1 deg. F. These two steps save the trouble of referring to ammonia tables for the information. The intersection of these two lines is at *E*. From the diagonal family of lines read the ideal temperature for the ammonia gas discharged from the compressor, at the point E, where *AB* and *CD* intersect. This point is between the line for 220 deg. and that for 230 deg. F., being closer to the former. This should be read 223 deg. F.

This temperature is different for every condition of operation, and is important. To the engineer it serves the same purpose as the normal blood heat does to the physician examining his patient. The engineer reads the thermometer on the discharge of the ammonia compressor. This probably reads a higher temperature, but may be lower than the figure from the diagram. Now the engineer begins to diagnose the case. If the temperature is higher than normal, it may be (1) that the suction gas is superheated; he can check this by looking at the thermometer on the suction and comparing its reading with the temperature read from the top scale of the chart. It may be (2) that the compressor valves are not working properly—a valve may stick open, may be jammed shut, may be leaky, may be so gummed that it is sluggish in its action, etc. These conditions all result in churning the gas, converting work into heat without useful results. It may be (3) that piston rings are broken, worn or poorly fitted, so that much leakage takes place. This also causes useless churning and recompression of gas, heating the gas and wasting power.



THE ENGINEER, AS DOES THE DOCTOR, SHOULD LISTEN FOR UNUSUAL SOUNDS

Since all causes of high discharge temperature have a damaging effect on the plant economy, they should be corrected. The high temperature is also bad for lubrication. When the cylinder is abnormally hot, the lubricating oil is so thinned out in body that it fails to lubricate well and cannot effectively seal the piston rings against leakage. Besides this, the high temperature tends to evaporate the oil and distill it over into the condenser, leaving behind a gummy and objectionable residue around the piston rings, cylinder walls and valves. The use of good oil relieves this trouble, but it is not fair to an oil manufactured to stand extremely low



CORRECT DISCHARGE TEMPERATURES FOR AMMONIA COMPRESSORS

temperatures, to demand that it shall also withstand excessively high temperatures, especially when these high temperatures are costing the plant owner many dollars a day.

So far we have considered discharge temperatures above normal. When below normal, one thing is quite sure—the suction gas is carrying liquid ammonia with it. A small amount of liquid does no harm in the suction and may improve the efficiency slightly, especially if it is in the form of a mist or fine spray, so that it vaporizes in the compressor. The reduction of temperature of the compressor has a desirable effect on the lubricating oil.

It sometimes occurs, when a very considerable quantity of liquid ammonia is drawn into the compressor, that the temperature of the discharge is only slightly lowered. This is a rather dangerous condition and often develops a knock in the cylinder. This happens when the liquid enters without being broken into a fine spray. The solid body of liquid does not readily vaporize and so passes through the compressor without producing the cooling effect on the compressed gas that it would if it were in the form of a mist.

One difficulty in diagnosing the operation of a compressor when liquid ammonia is entering the suction is that there is no clear indication when the valves and piston rings are not working properly. The poor action of these parts would normally cause a rise in the discharge temperature that could be detected by the thermometer on the compressor discharge. If the discharge temperature is below normal, the engineer cannot easily know whether this is the result of a small amount of liquid in the suction, with valves and piston rings operating well, or a large amount of liquid in the suction with poor operation of valves and piston rings. The only clear indication that he has is an increase in the power consumption or unusual sounds in the compressor.

Excessive reduction in the temperature of the compressor, in conjunction with the use of an unsuitable oil, results in bad lubrication and excessive frictional resistance. When the right oil is employed in a compressor having false cylinder heads that can lift in case excessive liquid ammonia is present, no serious effects need be expected from liquid ammonia in the suction.

Little need be said regarding the correction of these troubles, as most operating engineers are familiar with the method of procedure when the trouble is once located. The suction pressure should be brought to its required value by regulating the speed of the compressor (or by opening or closing clearance pockets if these are provided), and the suction gas should be brought to the desired condition by regulating the expansion valves. If the suction gas is at a temperature a few degrees above that corresponding to the back pressure, then the condition is as nearly as possible that for which the chart was constructed. The temperature of the discharge will then show little or much excess over the normal temperature indicated by the chart and will thereby indicate a good or bad condition of valves and piston rings.

The Inspection and Registration of Steam Boilers

General adoption of the A.S.M.E. Code and acceptance of certificates of members of the National Board of Boiler and Pressure Vessel Inspectors would eliminate the present confusion and benefit both manufacturers and users of steam boilers.

WHEN the legislature of a sovereign state overcomes its inertia and the apprehensions of its boiler-using interests and decrees that its Department of Public Safety, or Industrial Commission, or other appropriate functionary shall see that the boilers among which its people work and circulate are reasonably sure not to blow up, the first thing the functionary has to do is to decide what a boiler must be in order to be reasonably safe.

And if he is wise, he adopts the Code of the American Society of Mechanical Engineers as defining the requirements with which a boiler must comply to be acceptable. Then an inspection department is created to see that boilers afterward installed in that state comply with these requirements and that boilers already installed are operated under such pressures and conditions as not to menace the public safety.

In order that it may be known that a boiler does comply in material and workmanship with the requirements of the Code, it is necessary that it shall be inspected during construction. But each state inspection department cannot maintain an inspector in every boiler shop in the country or send an inspector to a distant state to see a boiler destined for use under its supervision through its formative stages.

An obvious way out of the difficulty is for the various state departments to accept the certificates of each other's inspectors. If a boiler is built in the West for use in the East, an inspector of the Western state could examine it during construction, stamp it with a symbol signifying that it is found to conform to the Code, fill out and sign the "data sheets," giving the necessary information regarding the design, material, etc., of the boiler and this stamp and certificate could be accepted by the inspection department of the Eastern state if it were known that the Western inspector was all right.

But how is the chief of the Eastern inspection department to know that the man who signs the certificate is worthy and well qualified? He may have no official assurance even that he is still an inspector in good standing in the Western department. And even if he had, that need not necessarily be adequate to the requirements of a system based upon honest engineering and a serious appreciation of the importance of its task. Patronage is still too much of a factor in state organization, and inspectors have often been appointed with regard to their serviceability on election day.

And so the chiefs of the various state and other inspection departments, or many of them, got together and organized the National Board of Boiler and Pressure-Vessel Inspectors, and they agreed to accept (or to recommend for acceptance to their directing authori-

ties) the stamp and certificate of any inspector who should satisfy the Board that he was competent and trustworthy. Such inspectors must undergo the scrutiny and investigation of the examining committee of the Board and, if found satisfactory, are given certificates and entered upon the list of those whose signature and certification will be acceptable. Each inspection department has a list of such certificated inspectors or can establish the standing of anybody claiming such certification at any time by communicating with the secretary of the National Board.

Before the completion of such an arrangement the situation with regard to stamping boilers was most unsatisfactory. In addition to the stamp or emblem furnished by the A.S.M.E., the use of which is restricted to boilers built in conformity with the A.S.M.E. Code, most of the states, counties, municipalities, etc., having inspection departments have stamps of their own which they required every boiler entering their jurisdiction to bear. Boilers such as those in the portable outfit of a contractor, which might be used in several states, or boilers built for stock, the destination of which was not known, had to bear the stamp of any state into which they were liable to go and this stamp had to be put on at the time of inspection. As a consequence it was not unusual to see small boilers with a multiplicity of stamps, one instance being known of twenty-six stamps on a single small shell. It seems incomprehensible that intelligent men would go on using such a cumbersome, time-consuming and wasteful system.

Inspector's Stamp Should Admit Boiler to All States

With the co-operation of the state departments effectuated by the organization of the National Board a simple national system becomes possible. When a boiler is completed, the certified inspector who has observed it during construction, stamps it or witnesses the putting on by the maker of a stamp signifying at the same time that the boiler complies in all respects with the requirements of the A.S.M.E. Code and that it is being stamped in the presence and with the approval of an inspector whose competence and trustworthiness have been certified to by the National Board. The legitimate presence of this stamp on a boiler, therefore, is its passport for admission to any state or division under the jurisdiction of any member of the National Board, because they have all agreed to accept A.S.M.E. Code boilers and the certificate of an authorized inspector that they are so. The certificate of the inspector is to cover such things as the details of the rivet seams, the transfer of mill stamps upon material, etc., things that would not be determinable from an inspection of the completed structure. His dictum would not, of course, pass it in the face of defects discovered by the receiving inspection department, and the passing of many such defects would be fatal to the continued usefulness of an inspector.

When the shop inspector witnesses the stamping of a boiler with the National Board symbol, its manufacturer's name and its identifying number, he makes out a certificate to that effect and registers it with the National Board together with the data sheet of the boiler. A duplicate of the certificate and of the data sheet goes to the Inspection Department of the state where the boiler is to be used. When the boiler is installed, this certificate, data sheet and stamp are evidence that it has been built in accordance with the Code, and if the inspection department of the state in which it is installed is represented upon the National Board and no fault is found with the boiler by present inspection, it will be admitted and a permit issued for its installation and use. By registering the data on all boilers in this manner, the National Board would become a registry of vital statistics for the steam boilers of the country. If this boiler, recognizable by its stamp, ever turns up again for installation elsewhere, is offered for sale in the second-hand market, explodes or otherwise attracts attention to itself, there in the archives of the National Board will be the record of its making and inspection, with its data sheet giving the manufacturer of its material, results of mill tests, details of design and everything that is of interest concerning it.

It would seem that this system is so much superior to the present confusion that there would be a rush on the part of boiler manufacturers and users to get it into operation.

The thing that will get it into use quicker than anything else is to use it.

If every manufacturer of an A.S.M.E. Code boiler would have it stamped or registered in this way the system would be in operation. The more states that establish boiler inspection departments and adopt the Code boiler as their standard, the more universal will it be. When all the states have done this, there can be none but safe boilers made and used.

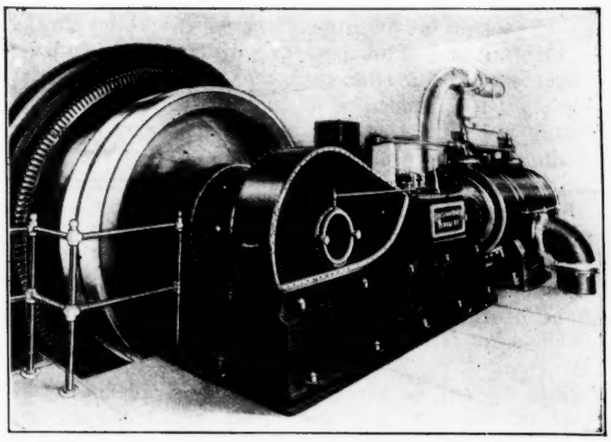
Registration Fee Nominal

The cost of maintaining the system would have to be met by a registration fee, but if every new boiler were registered, the fee need be only nominal to make the Board self-supporting. The progress of the Board was hindered by putting a flat price of $2 per boiler upon this service. This is a considerable percentage of the selling price of small boilers, which are made in great numbers. It is hoped to extend the usefulness of the Board and to lead toward that universality of adoption essential to the completeness of the system by the considerable reduction which has been made in the change. It is now a graduated charge ranging from 25 cents per boiler up.

With the fee reduced to a nominal amount, the only thing that will deter a boiler manufacturer from registering his boiler is fear of the adequacy of the service rendered. After he has paid his fee and gone through all the motions, has he any assurance that his boiler will be everywhere accepted? If he cuts loose from the present practice, bungling and unsatisfactory as it is, may he not get into a position where some recalcitrant inspector may refuse to pass an expensive job and leave him in the lurch?

Such a possibility seems remote. No court would sustain a department or an inspector in forbidding the installation and operation of a boiler which could be shown to be reasonably safe. And a boiler which by this process of inspection and registration could be shown to comply with the A.S.M.E. Code would be accepted as reasonably safe by any court in spite of its failure to comply in some minor detail with the personal views of a local inspector. Furthermore, in adopting this system the boilermaker gives up no safeguard that he already possesses, but has a record of his job and its approval in his own works, in the archives of the National Board, in the department where the boiler is installed, and in the records of the insurance company if it is insured.

Setting Ames Unaflow Valves



THE unaflow engine is rapidly supplanting other less efficient steam engines. This requires the operating engineer to be acquainted with the general design of these engines and with the method of setting the valves. This article, dealing with the Ames, is the second of a series of articles on American unaflow engines and the methods of setting the valves.

THE increasing use of unaflow engines in power plants has aroused the interest of engineers in the operating procedure to be followed, especially as to the correct methods of setting the valves. The unaflow engine almost universally uses poppet valves, and their adjustment is not the same as with Corliss releasing valves. While the procedure with all engines is similar, there are certain details peculiar to each make.

The cylinder and valves of the Ames unaflow engine as arranged for condensing operation are shown in Fig. 1. The steam enters the cylinder through the steam valves at each end of the cylinder. Exhaust, as with all unaflow engines, is through a center belt of ports.

The details of the steam valve appear in Fig. 2. It is of the double-beat poppet type; the upper valve *A* is a resilient steel disk shrunk onto the cast-iron body

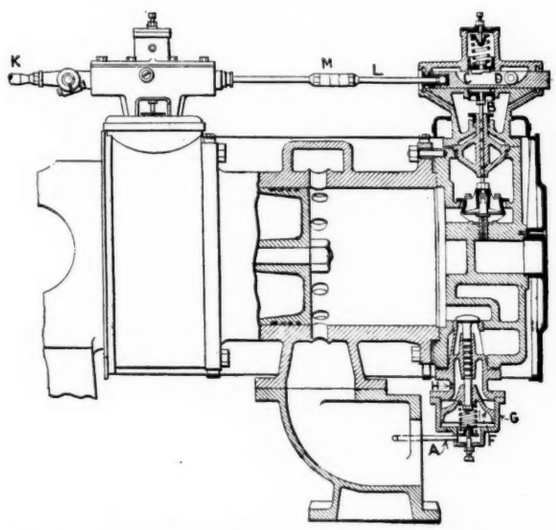


FIG. 1—AMES UNAFLOW ENGINE FOR CONDENSING OPERATION

of the valve. This provides for any unequal expansion of the valve body and cylinder head, thereby eliminating danger of leakage. The valve spindle is screwed into a round crosshead *B* which slides in the valve bonnet and carries a cam *C*. Through the slot in the crosshead moves the roller rod *D* under control of the governor eccentric. A roller on the rod contacts with the cam *C*, and as the eccentric, which is controlled by a shaft governor, turns over, the cam is raised and in turn lifts the valve from its seat.

When the engine is built for non-condensing service, the piston has concave heads. This provides enough clearance volume to hold the compression pressure to a reasonable amount.

A low clearance volume is essential if maximum economy is to be obtained. Consequently, for condensing operation the piston has plain ends and the clearance is made as small as is mechanically possible. It often happens that an engine loses its vacuum, and unless some relief is provided the resulting excessive compression might wreck the engine. In the Ames unaflow the danger is avoided by the adoption of the automatic bypass valves shown in Fig. 1.

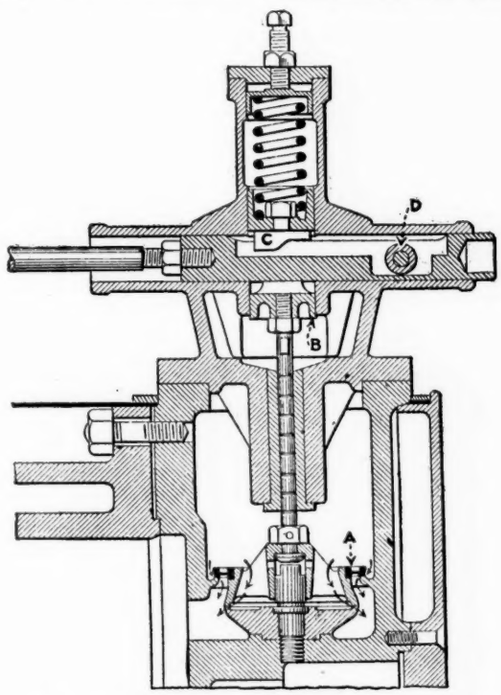


FIG. 2—DETAILS OF STEAM-VALVE GEAR

The bypass valve consists of a mushroom valve on the stem of which is mounted a piston or dashpot *F*, moving in a cylinder *G*. The operation is as follows: The lower end of the cylinder *G* is connected to the engine exhaust-port belt by the pipe *A*. The pressure acting on the lower side of the valve piston *F* is that

of the condenser, say 2 lb. absolute. Atmospheric pressure is exerted on the upper face of the piston through the opening *H*. This pressure difference is sufficient to overcome the spring pressure, and the valve stays closed. If the engine's vacuum is lost, the pressure through the pipe *A* will be atmospheric and just counterbalance the pressure on the upper face of the piston. The spring pressure lifts the valve. Communication is thereby opened between the engine cylinder and the auxiliary clearance chamber. On the compression stroke the trapped steam is compressed into a clearance space greater than the cylinder clearance by the volume of the auxiliary chamber. The final compression pressure is then limited and all danger of fracture eliminated.

When the engine leaves the factory, tram marks are placed on the rods and rod heads, the tram distance being stamped on each. If for any reason these marks

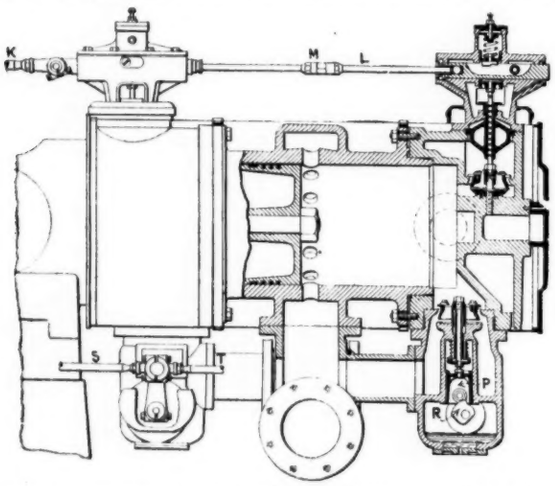


FIG. 3—CONTROLLED COMPRESSION BY AUXILIARY EXHAUST VALVES

are absent, the setting of the valves is quite easily accomplished. The eccentric rod should be connected to the rocker lever of a length so that the eccentric causes the rocker to travel equal distances on each side of its central position. The valves' stem length should next be adjusted to give 0.002-in. clearance between the roller and the flat surface of the cam. This may be measured through a peep hole provided in the valve bonnet.

The engine should then be turned to crank dead center and the reach rod *K* adjusted so that the crank-end valve roller will just touch its cam. The engine is next turned to head-end dead center and the rod *L* lengthened or shortened by the nut *M* to cause the head-end valve roller to contact with its cam.

This completes the preliminary valve setting. The engine should be run and indicator diagrams taken to see if the lead on the two ends are enough to give a good diagram.

When a unaflow engine may be called upon to operate with a varying exhaust pressure, auxiliary exhaust valves are advisable. For such conditions the Ames unaflow engine is fitted with the type of auxiliary valve shown in Fig. 3. The valve is essentially the same as the steam valve, being double-beat with one resilient seat. To the valve stem is fastened a crosshead carrying a roller *P*. The roller is lifted by the cam *R*, which in turn is moved by a lever arm driven by the eccentric through a reach rod, as shown at the crank end of the cylinder.

In setting these auxiliary valves, proceed as follows: Remove the covers on the side of the cages opposite to the rocker levers. This will allow a full view of the cams. If the dead-center points are not marked on the engine, these are established in the usual way. The engine is then turned over until the piston is one inch from the end of its head-end dead-center position. The auxiliary-exhaust reach rod *S* is adjusted until the crank-end auxiliary-exhaust cam *R* just touches the valve roller *P*. Continue to turn the engine over and note the piston position when the auxiliary valve closes. This should be a distance of about two-tenths the stroke from the crank end. The engine is then turned to one inch from the crank-end dead center and the head-end auxiliary-valve cam set to touch its cam, by adjusting the rod *T*.

The exhaust-valve roller should clear the cam by about 0.003 in. at a point on the round part of the roller just ahead of the lifting part of the cam, as indicated by the mark on the cam. An engineer should not allow the clearance here to be too large, for the smaller the clearance the quieter is the valve action. On the other hand, there must be some clearance or the valve will not close, allowing leakage into the exhaust at all times. The point in the return stroke at which the auxiliary valve should close depends upon the back pressure carried—the higher the back pressure the later must be the closing of this valve.

Indicator diagrams should be taken, and any errors in valve adjustment may then be detected by examination of the diagrams.

Notes on Semi-Diesel Engines

The semi-Diesel engine mechanically is far simpler than the Diesel, but its operation is more complex. In the latter the cylinder temperature at the end of compression is so much above the self-ignition temperature of the fuel that ignition seldom fails from low temperatures. The semi-Diesel compression pressure is held as low as is possible and still secure firing. It follows that a slight disturbance of the balance between requirements and operating conditions as to the compression pressure will cause the engine to fail to ignite the fuel.

Frequently, the engine is operated with too low a cooling-water temperature. This cold water serves to reduce the combustion-chamber temperature, and firing becomes irregular even though it does not entirely cease. This is particularly true on light loads. At such times the jacket-water temperature must be carried higher than usual; 160 to 180 deg. F. is not too high.

A cooling-water jacket filled with scale will cause the engine to run hot. The combustion chamber will become overheated at the throat, and the oil spray in striking this red-hot surface will crack and deposit carbon. This hot carbon will raise the temperature so high that preignitions will occur if injection is early. Even with late fuel injection the hot carbon will ignite the oil in its immediate vicinity before the entire oil and air charge has become thoroughly mixed. A high wave of pressure will travel across the cylinder, causing the well-known pinking or detonation, which will, if excessive, cause the engine to pound the bearings and overheat.

This same detonation is also produced by exhaust lines of improper length. Part of the exhaust gases are, in this way, redrawn into the cylinder and serve to ignite the fuel at some local spot, producing detonation and heavy pounding.

Influence of Mechanical Conditions on Lubrication of Internal-Combustion Cylinders

By W. F. OSBORNE
Supervisor, Manufacturers' Service, Texas Co.

BEFORE we can make any attempt to pick out a suitable oil for the lubrication of the power cylinder of an internal-combustion engine, we must understand fairly well what is going on inside when the engine is running. There are so many types of engines differing in mechanical construction, in the fuels they burn and in the methods employed to handle the fuel, that it is a difficult matter to lay down any general rules that might be applicable to internal-combustion cylinders as a whole.

Considering only the power cylinder, three things are expected of the oil. It is supposed to reduce the friction of the piston and rings as they move over the cylinder wall, to eliminate the wear of pistons, rings and cylinder, and to assist the rings in forming a proper piston seal.

In any engine the friction of the piston and rings is influenced by the smoothness of the surface of the cylinder and the piston, by the kind of metal from which the cylinder, piston and rings are made, by the rubbing speed of the piston over the cylinder wall, the clearance between piston and cylinder, ring pressure, cylinder diameter, stroke and piston length. In addition to these purely mechanical factors there are many others, such as the characteristics of the lubricant and the conditions surrounding the combustion of the fuel, all of which will be discussed later.

After the engine is once installed, the operating engineer has little opportunity to change any of the mechanical factors, except the type of piston and rings. Cylinder diameter, piston stroke, cylinder metal and piston speed are fixed by the engine builders. Piston speed can be varied on many internal-combustion engines, such as the automotive and the marine types, where variable speed is necessary.

With the exception of the slow-speed double-acting gas engines burning natural gas, producer gas or blast-furnace gas, and large Diesel engines, the cylinder diameter and stroke are much smaller than are found in steam cylinders. These smaller cylinders, as a rule, are simpler to lubricate than the large steam cylinders.

The metal from which the cylinder is made is fixed at the time it is cast, although cylinders that have removable liners are capable of improvement if it is found that one type of liner is not entirely satisfactory. The steel liner is probably a little more difficult to lubricate at first than the cast-iron liner, possibly because the latter has greater porosity and, being made of softer metal, wears down to a smooth working surface more quickly. Attention is called to the fact that a brand new engine will have much higher frictional losses than it will have after it has been "run in." During the period of running in, plenty of oil ought to be fed, until the high spots have been worn down and the piston and cylinder develop a true running fit.

The surface of a properly made cylinder will be very smooth and should take on a high polish after the engine has been running for a short time. When properly lubricated, this surface will remain indefinitely and until wear takes place there will be little change in the frictional losses.

The metal of the piston can be changed simply by putting in new pistons. One important thing to look after in making such a change is to see that there is a proper clearance between piston and cylinder to take care of the expansion of both when they are heated to the running temperature. Some metals, such as aluminum, have a higher coefficient of expansion than cast iron, and it is necessary to allow a greater clearance when the cold piston is fitted to the cylinder in order to prevent seizing when it reaches its operating temperature.

Piston speeds of internal-combustion engines range from 600 to 1,800 ft. per min., much higher than is common practice in the steam cylinder. We should expect that for the same size the total friction loss of the internal-combustion cylinder would be greater, owing to this high speed, than that of the steam cylinder, assuming that each received the same degree of lubrication.

When a moving surface floats on a film of oil, the frictional loss varies inversely with the thickness of the film. A large piston clearance completely filled with oil would tend to lower the friction and small clearance would increase it. There is a possibility, however, of getting the clearance so large that the leakage of gas would blow the oil off the cylinder and no lubrication would be secured at all.

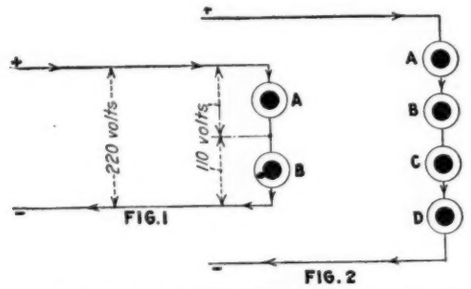
The total area of the piston in contact with the cylinder also has a considerable influence on the frictional losses—so much so that some engine builders have cut away a portion of the piston skirt on single-acting engines in order to reduce the area and lower the frictional losses.

Ring pressure has a great influence on the friction losses, and it requires a very nice balance of the radial pressure to get proper results. If the pressure of the ring is too small, gas will leak and the power of the engine will be decreased. If the pressure is too high, the oil will be scraped off the cylinder, cylinder friction will be increased and the horsepower of the engine decreased.

Aside from the purely mechanical features influencing friction losses, there is the completeness of the separation of the rubbing surfaces from all metallic contact and the frictional resistance of the oil film itself. We would naturally expect that the lowest friction would exist when piston, rings and cylinder were not in actual contact, there being a complete film of oil between them. Whether it is actually ever possible to get the piston and rings riding on a film of oil in the manner of a shaft bearing is debatable. It is doubtful if it ever occurs. The sharp edges of the rings tend to scrape the oil off rather than to draw it under the rings. On the other hand, there must be some oil between the rings and the cylinder or there would be no lubrication at all. Some sort of lubrication is certainly secured, whether film support or partial or so-called "greasy" lubrication.

Connecting Resistances in Series

A series circuit is one in which two or more devices are so connected that the current that flows through one must also flow through the others. In other words, there is but one path in the circuit. In Fig. 1 is shown two lamps connected in series to an electrical source. Current flows from the + terminal through lamp *A*, then through lamp *B* back to the negative terminal. Here it is seen that the two lamps form but one circuit, and the current that flows through one must flow



FIGS. 1 AND 2. LAMPS CONNECTED IN SERIES

through the other. Carrying this idea a step farther, take the case in Fig. 2. Here four lamps are connected in series and, as in Fig. 1, there is but one path for the current. This is from the positive terminal through lamps *A*, *B*, *C* and *D* back to the negative terminal.

Where voltage sources are connected in series, the resultant voltage is the sum of all the sources; that is, if a 50-volt generator is connected in series with another unit generating 75 volts, the resultant voltage would be 50 + 75 = 125 volts. When resistances, such as lamps, coils of wire, etc., are connected in series, the resultant resistance is the sum of the unit resistance in the circuit. In Fig. 1, if each lamp has 220 ohms resistance, the two lamps in series will have 220 + 220 = 440 ohms. This is just as it should be, since if the lamps are for 110 volts and connected to 220 volts, they are connected to double the voltage of one lamp. Therefore, since the resistance is double, the current will be normal. *Amperes* = *volts* ÷ *ohms*, then with one lamp connected to 110 volts, the current equals 110 ÷ 220 =

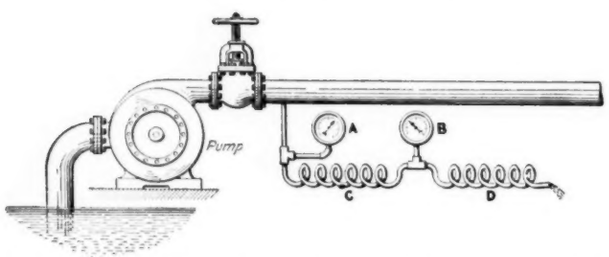
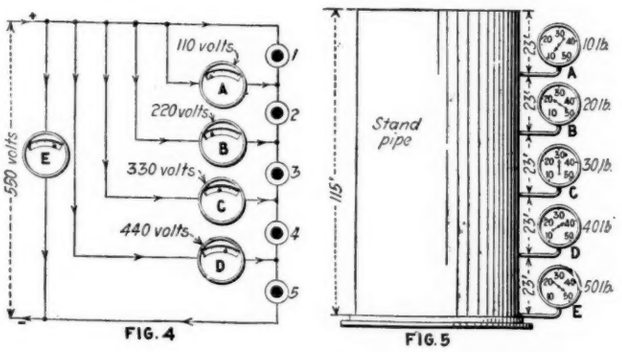


FIG. 3. COMPARISON OF PRESSURE IN A PIPE LINE WITH CONDITIONS IN FIG. 1

0.5 ampere. With two lamps in series on 220 volts the current equals 220 ÷ 440 = 0.5 ampere, as before.

Where devices are connected in series across the circuit, the voltage is divided up between them in proportion to their resistance. A hydraulic analogy of this law is given in Fig. 3. If the two coils *C* and *D* are identically alike and gage *A* indicates a pressure of 50 lb., then gage *B* will indicate only one-half of 50, or 25 lb. To overcome the resistance offered to the flow of the fluid through coil *C*, 25 lb. of the pressure at *A* has been used up. This leaves the other 25 lb. to cause the fluid to flow through coil *D*. This is identically what would happen in Fig. 1. If the two lamps are alike and are connected across a 220-volt circuit, one-half of 220, or 110 volts, will be applied across each lamp. This is just what is done when it is desired to connect 110-volt lamps on 220-volts—they are arranged in groups of two in series and connected across the circuit. Similarly, on a 550-volt circuit, five 110-volt lamps may be connected in series and across the line. Each lamp will then be operating on one-fifth of 550 volts, or 110, just as if one lamp was connected across a 110-volt circuit. In Fig. 4 are shown five lamps in series across a 550-volt circuit, with voltmeters connected from between the different lamps and one side of the line. What each instrument should read is indicated on the meter. Voltmeter *A* is connected from the + line to between lamps 1 and 2; that is, voltmeter *A* is connected across lamp No. 1 and will therefore read the volts required to cause the current to flow through this lamp, or 110. Voltmeter *B* connects from between lamps 2 and 3 to the + line and will therefore read the volts required to cause



FIGS. 4 AND 5. ILLUSTRATES VOLTS DROP ALONG AN ELECTRIC CIRCUIT

the current to flow through lamps 1 and 2, or 220 volts. This condition is similar to that illustrated in Fig. 5. If the standpipe in the figure is 115 ft. high and filled with water, the pressure at the bottom of the tank will be approximately 50 lb. per sq.in. since a column of water one square inch cross-section and 12 in. high weighs 0.434 lb. If a pressure gage is connected in at a point one-fifth the way down the tank, or $\frac{1}{5}$ of 115 = 23 ft. from the top, this gage will indicate $\frac{1}{5}$ of 50, or 10 lb., as shown at *A*, which is similar to voltmeter *A*, Fig. 4. A pressure gage *B* connected into the standpipe two-fifths the way down from the top as at *B* will read two-fifths of the pressure, or 20 lb., just as voltmeter *B*, Fig. 4, reads 220 volts, or two-fifths of the total voltage. As gages are connected in at points farther down the tank, higher reading will be obtained until at the bottom, *E* will read the total pressure or 50 lb. just as voltmeter *E*, Fig. 4, reads the total 550 volts.

In all cases referred to devices having like characteristics have been connected in series. It is seldom possible to connect devices of unlike characteristics in series and obtain satisfactory operation. For example, if a 120-volt, 200-watt lamp, was connected in series with a 110-volt, 60-watt lamp and connected across a 220-volt circuit, as the two lamps are in Fig. 1, it would be found that the 200-watt lamp would burn dim, where the 60-watt lamp would light up very bright, and would burn out if left on the circuit for a short while.

EDITORIALS

Another Coal Dope

TO HIS surprise and chagrin the editor noticed among the exhibits at the exposition in connection with the late convention of the National Association of Stationary Engineers, at Des Moines, a booth devoted to the exploitation of Koal Ekonomizer. According to the literature dispensed, "it is a chemical compound composed solely of chemicals scientifically made for the purpose of extracting the sulphur from coal." It is guaranteed to prevent coal from air-slaking, and there is no spontaneous combustion where the coal is treated with it. It "makes two tons of coal do the work of three tons"; "eats the soot, allays the clinkering, gives bright, hot fires, consumes soot and gases"; " two packages used on two tons of coal gives heat units of three tons."

The editor collected a sample and had it analyzed. The chemist says that it is composed of about forty-two per cent sodium chloride, fifty-three per cent potassium chloride, five per cent naphthalene and a little coloring matter. He presumes that it is simply a pulverized ore which naturally contains the foregoing proportions of the chlorides of sodium and potassium. The idea of its having any effect on sulphur, he says, is a joke.

Sodium chloride is common salt. The price of one package of two and one-half pounds is one dollar, and there is just as much reason to expect any increase of thermal value in the coal, or any improvement in its combustion, from cutting up a dollar bill and scattering it upon the ton of fuel as there is in paying it for two and one-half pounds of this dope, dissolving it in water and sprinking it upon the coal according to directions.

The Government Loses Another Public Servant

THE handicap suffered by many government departments through failure to retain their personnel is again exemplified by the selection of Dr. S. W. Stratton, Director of the Bureau of Standards, to become head of the Massachusetts Institute of Technology. Commenting on Dr. Stratton's resignation, Secretary Hoover said: "The inability of scientific men in the government service to support themselves and their families properly under living conditions in Washington and to make provision for old age, makes it impossible for any responsible department head to secure such men for public service at government salaries."

A technical man of ability may be attracted to government service for one of several reasons: He may have an independent source of income and the atmosphere of public service may appeal to him. It is a good place in which to secure a reputation that will lead to something worth while in the commercial world, especially if research is involved. Again, he may accept a government position as a temporary expedient when other positions are scarce. The difficulty is in holding such men, and when they leave, the department head is often confronted with the necessity of replacing them with men of caliber commensurate with the mediocre salary stipulated.

Dr. Stratton was with the Bureau of Standards for twenty-one years. During his administration the Bureau grew from a small beginning to the largest physical laboratory in the world. A measure of its growth are the appropriations for carrying on its work, which have increased tenfold. His recognized capacity for simultaneously directing the work of a large number of diversified technical problems will be especially valuable in his new calling, but it is this diversified character of the work that will make the selection of his successor at the Bureau a difficult one.

B.t.u. or Dollars and Cents?

IN HIS paper delivered at the recent N.A.S.E. convention, Thomas G. Thurston drove home one fact that operating engineers should never forget. It is that the average business man has one language which he understands better than any other—the language of dollars and cents. With him it is particularly true that "money taiks." He may appear to have an interest in buildings, machinery, organization and (occasionally) even in the elusive B.t.u. that cuts such a large figure in the daily life of the engineer. But let any one of these things become unimportant from the point of view of money making, nine times out of ten it immediately ceases to interest the business man.

It is further true that the average business executive is glad to leave technical details to his department heads except where he lacks full confidence in their knowledge or judgment. In this connection the power plant is rightly looked upon as a department and the operating engineer as a department head.

The business executive demands that the power plant supply a certain necessary service at the lowest possible cost. Aside from that he is not interested, except in the rare cases where the power plant may be his hobby. Yet how many engineers seek approval of needed expenditures with arguments about B.t.u. saved per hour, increases in thermal efficiency, etc.! Such arguments, even when perfectly sound, often fail because the business man does not appreciate the relation of these things to his profits.

Would it not be better for the operating engineer, when dealing with the business man, to keep the B.t.u.'s and efficiencies in his pocket and submit instead a reliable estimate of costs and savings, backed by his reputation as an engineer? The approach might be something like this: "You are a business man and I am an engineer, so I will tell you what these improvements will cost and what they will save, leaving it to you to decide whether this investment is worth while or not. The improvements that I suggest will cost —— dollars and will result in a gross saving of —— dollars per year. Allowing —— dollars per year for operating costs, repairs, etc., and figuring interest and depreciation at —— per cent, the net yearly saving will be —— dollars. If you wish, I will gladly go

through the engineering details with you, but I am willing to take the entire responsibility for the substantial correctness of my estimate. Now it is up to you, as the man responsible for the profits of this business, to decide whether you are willing to spend —— dollars to get a net return of —— dollars per year."

Of course, it wouldn't be worded exactly like that, but here, in substance, is the kind of an approach that should get the attention and support of the business executive. This is on the assumption that the engineer knows what he is talking about and can impress the executive with that fact.

Centralized Control of Power Equipment

PRESENT tendencies are toward more centralized control of power equipment, not only in the power plant, but also for industrial motors. On the electrical end of the power station centralized control has become highly developed, not only in large central stations and industrial power plants, but also in small-sized installations. The wide adoption of remote-control equipment within recent years has done a great deal to make possible an even greater degree of control centralization for electrical equipment. This adoption of remote control has not only simplified the station layout, but has also made possible the concentration of the control of the largest plants into less space than would have been possible for plants one-tenth the size a few years ago with hand control.

Remote control has not only resulted in centralizing the control and concentrating the responsibility for operation, but has added greatly to the reliability of the service, by allowing the control room to be located where the operator will not be disturbed by the other features of plant operation. Quietness, cleanliness and good lighting are three requisites of the modern control room, and can be had only by remote control.

For the generating units the control has been largely centralized in the operating room; even the turbine, after being brought up to speed, is under the control of the operator. However, this is not the condition in the boiler room. Although systems of centralized control for this part of the plant have been developed, their adoption has made slow progress, particularly with coal-fired boilers. If the load varies through wide ranges on a generator, the voltage is the only characteristic of the machine that may be seriously affected, and this can be easily taken care of by an automatic regulator. On the prime mover the governor can be depended upon to regulate the flow of the steam to meet the load requirements.

When the load changes on a boiler, no such simple conditions exist as with the prime mover and generator. If the load increases, more coal must be fed to the fire and will require an increase in the air volume. This means that the draft conditions must be changed to handle the increased volume of gases. To meet an increased demand for steam, for a short period the flow of feed water should decrease to allow the steaming capacity of the boiler to increase until the fire can adjust itself to the new condition. Even when the best coal is fired, there is the liability of the feed to one or more of the stoker retorts being stopped; and this, if not remedied, will affect the firing. A change in the thickness of the fire on the grates, the formation of clinkers or a hole blown in the fire, all change the quality of combustion and the efficiency of the boiler plant and require special attention for adjustment. Although the advantages of centralized control for boilers have long been realized, the difficulty of obtaining a satisfactory control under these conditions has retarded the progress so that in general the most satisfactory arrangement at present is to centralize the control of each boiler at the unit itself.

Where liquid or gas fuel is used, the problem of centralized control is a comparatively simple one since the fuel and air can be reliably controlled automatically. When coal is pulverized, it takes on more or less the characteristics of a gas and its flow can be controlled in much the same way. Increased adoption of this class of fuel which has taken place during the last few years will undoubtedly open up a new field in boiler-plant operation. When coal is pulverized, many of the difficulties of burning it on a grate are eliminated and automatic control is possible.

The Navy's Engineering Work During the War

THE designation of Friday, October 27, as Navy Day reminds us that in spite of the absence of any noteworthy naval victories during the World War the Navy rendered vital service to the nation, from an engineering as well as from a military viewpoint.

That there should have been noteworthy engineering developments is not strange when one considers the tremendous scope of the Navy's engineering activities. The Bureau of Engineering, headed by Rear Admiral Robert S. Griffin, was responsible for the investigation, choice, design and installation of every piece of equipment for the propulsion of every naval vessel, whether operating on the water, beneath it or in the air.

It was the Bureau's constant aim to find the best means of doing a thing and then to develop and use that means regardless of cost. Thus, electric drive for battleships and cruisers was chosen over the protests of a host of exponents of direct drive through reduction gears, because it had proved itself the best form of drive for these craft. In radio there was constant research, resulting in the development of the radio compass, increase in the efficiency of trans-oceanic radio service, enlargement of the range of radio for aircraft service, and so on.

The Bureau's duties extended even to aircraft machinery. The Navy's program of service machines demanded quantity production of an engine of great power combined with lightness and reliability—the standard four-hundred-horsepower Liberty engine was the result. Not content with this achievement, the Bureau appropriated fifty thousand dollars for the development of a light, compact steam-power plant for aircraft service, designed to be fitted into an existing type of plane so that a direct comparison might be made with the gasoline-engine drive. This work was undertaken in March, 1918, and by November the first experimental plant was ready for the preliminary tests.

In all these fields the Bureau of Engineering showed itself ready to back to the limit any idea or project giving promise of improvement over existing methods, and it was indeed inevitable that out of these gropings toward greater efficiency in warfare there should have come developments of corresponding value in times of peace.

PRACTICAL IDEAS from PRACTICAL MEN

How Coal Should Be Sold

Even in the times when we find coal salesmen calling on us every week in numbers, seeking our business, we cannot get anything definite out of them as to just what their coal will do. Their line of talk is something like this: "We have an excellent grade of coal, mined from the thin end of an extra-fine grade of steam coal; it is washed, comparatively free burning, does not clinker, low in ash, high in B.t.u. and—well, we would like to get your contract." We ask the salesman what he can guarantee for his coal as compared to the coal we are now burning and he answers: "We guarantee nothing." Funny, isn't it? Yet he wants us to contract with him blindly because we like him, because he is a nice sort of chap. Really, that is about the size of it.

Of course anyone can say to a salesman: "Why, yes, I guess you can ship us a couple of cars, and when it comes in we will have a clear space in our bins and will give it a thorough test and tryout; and if it shows up well, we will be glad to enter into a contract with you." The salesman thanks us most graciously, offers us a long black cigar, asks about the next train, or the roads to the next town and departs, satisfied that he has *sold* another order. As a matter of fact, he did not sell it; the buyer merely told him to ship because it was different coal from any other he had used, and *hoped* that he might get better results.

Now, I have suggested to several different coal salesmen a rather elaborate plan that would be a practical solution to these difficulties.

First, get all the mine operators and dealers to organize and then systematize, and finally deputize; all for the purpose of being able to guarantee to the consumer that certain coal will give certain results under specific conditions. This will mean that considerable money will have to be raised, for it will be necessary to erect a plant suitably located near the mines. Install, in this plant, boilers of the principal makes and types generally found in the average plants in the territory served by these mines. Make practical tests of their coals under predetermined operating conditions. For instance, in my little plant I have certain load conditions. These can be readily duplicated in this test plant through the use of steam-flow meters. I can obtain steam-flow meters and install them and obtain daily 24-hour records of our steam supply. It matters not what the steam is used for, nor where it goes after it passes by the meter, and after this is done, the charts are sent to the test plant, where they are recorded and filed together with a complete record of the type of boilers used in our plant and the method of firing, the type of grate bars, and all other data pertaining to the steam-producing equipment we have in operation.

Second, this testing organization will advise the members that our specifications are on record; the dealers will then make arrangements with us (and we will be glad to stand our share of the expense) to test their coal under our operating conditions and determine what we can expect and have a right to expect from it. They, on the other hand, can guarantee to us certain results under our operating conditions.

One can readily understand what such a program would mean if carried out to its full conclusions. It would mean that the consumers would get what they pay for; that coal would then be sold on what it would do in my plant—not what it shows from laboratory analysis; for after all, what do we care about B.t.u. or percentage of ash or sulphur, or moisture or any of the other things our chemists tell us? Let the test plant worry that out. We cannot afford to install a laboratory nor to engage a chemist, but what we can afford is to pay for results, for after all, results are what count.

I realize that such a plan, if carried out, would mean several things: It would mean that the coal from the various mines would be graded as it should be; it would mean that the consumer would get what he pays for; it would mean that some mines would be put out of business as no one wants to buy dirt at three or four dollars a ton and then pay from two to three dollars more a ton for freight, so the dirty coal would be placed in its proper class, the good coal in its class, and so on. Also, there is another item—and this one is for the benefit of the organization—they would install electric generators and, when conducting tests, would sell the current to the nearest power producer or electric company.

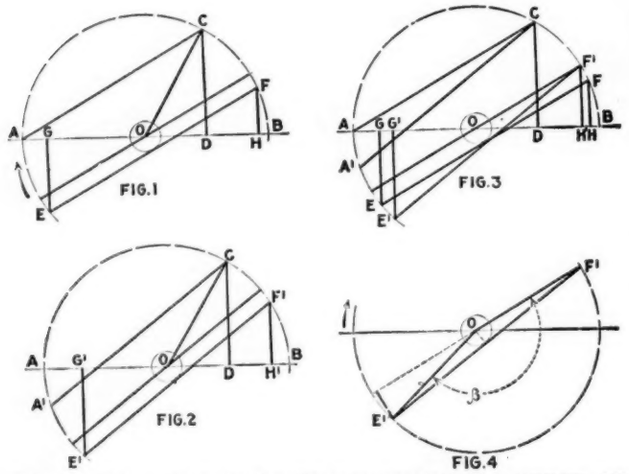
Furthermore, it would mean that we little fellows would have the opportunity to send our firemen to this plant for a one or two weeks' course in hand firing, where they would be taught to take advantage of the tricks of firing that mean the saving of fuel—taught at the same type of boilers operating under the same load and draft and other conditions.

C. R. HODGSON.
Union Springs Light & Water Works,
Union Springs, Ala.

Finding Exhaust Lap with a Given Valve Travel

Inside, or exhaust lap, on a steam-engine valve is less frequently considered and understood than outside, or steam lap. It operates entirely distinctly from steam lap except that, naturally, the width of each must be considered in relation to that of the ports and bridges in the valve seat.

To find the amount of exhaust lap for a given valve travel, the piston stroke and the valve travel being ex-



FIGS. 1 TO 4—VALVE DIAGRAMS SHOWING EFFECT OF EXHAUST LAP

pressed on different scales on the same diagram, we may work as follows:

We will first consider a valve without lead and ignore the influence of connecting rod; that is, we will suppose the crank to be driven by a Scotch yoke.

Let AB in Fig. 1 represent to a certain scale the piston stroke as well as the valve travel to some other scale, and C and D the crankpin and piston positions respectively for cutoff. About the center O we draw a circle having as radius the desired exhaust lap. Connect A and C; draw the chord E tangent to the exhaust lap circle; then the points F and E will represent the crankpin positions for release (exhaust commencement) and compression (cushion) respectively; and the perpendiculars from these points to the diameter AB will give H and G as the piston positions for these two occurrences.

Introducing the complication or alteration occasioned by lead (see Fig. 2) let A' represent the crankpin position for admission; then (ignoring the fact that the steam lap must be diminished to keep the cutoff the same) we draw $A'C$ and make the chord $E'F'$ parallel to $A'C$, and tangent to the exhaust-lap circle. Then E' and F' will be the crankpin positions for cushion and release, and G' and H' those of the piston for the same events.

Fig. 3 shows Figs. 1 and 2 combined.

In general we may say that exhaust lap leaves the admission unchanged, lets expansion begin as before but continue longer, delays release and hastens compression.

To find the positions of the crankpin and piston at release and compression points for a given exhaust lap by calculation is less easy than to calculate the lap for any desired release and cushion.

The ratio between the exhaust lap and half the valve travel is expressed by $\frac{1}{2}$ sin (180 deg. — β) divided by the sine of $\frac{1}{2}\beta$; β being the lap angle.

Thus supposing the exhaust lap angle $E'OF'$ (Fig. 4) to be 166 deg. we have $\frac{1}{2}$ sin (180 deg. — 166 deg.) divided by the sine of 83 deg. = $\frac{1}{2}$ sin of 14 divided by the sine of 83 deg. or 0.24192 ÷ (2 × 0.99255) equals 0.1228; so that if half the valve travel is 2, we have the exhaust lap 0.1228 × 2 = 0.2456.

To get the piston position for any desired crankpin position, we refer both to a circle with 1-in. radius. Thus piston position 0.8 stroke gives a crankpin position at an angle having as cosine (0.5 — 0.2) × 2 = 0.6, which is the cosine of about 23¾ deg. from one dead center or 156¼ deg. from the other.

New York City. ROBERT GRIMSHAW.

Old Air Receiver Used as Blowoff Tank

The blowoff lines from our boiler plant were formerly carried out under the wharf and into the bay. Recently, a blowoff tank was installed, as the hot water and steam discharged under the wharf were having a bad effect on the piling and planking.

The illustration shows how an old steel air receiver was converted for this purpose. Two 12-in. flanges were riveted at diametrically opposite locations near one end, for the discharge and vent connections. To the lower connection was attached a 12-in. pipe, 8 ft. 6 in. long, with a 90-deg. elbow at the lower end, this length of pipe being sufficient to keep the outlet under water at all tides. To the upper flange was attached a 15-ft. length of 12-in. pipe with an exhaust head as shown. This pipe serves as a vapor or steam vent. The exhaust

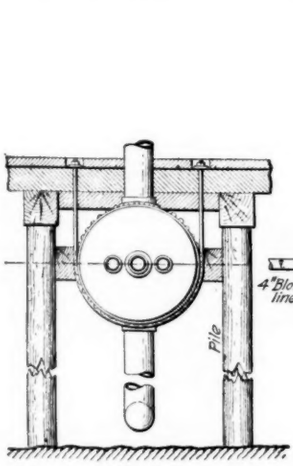


FIG. 1—METHOD OF SUSPENDING TANK BELOW WHARF

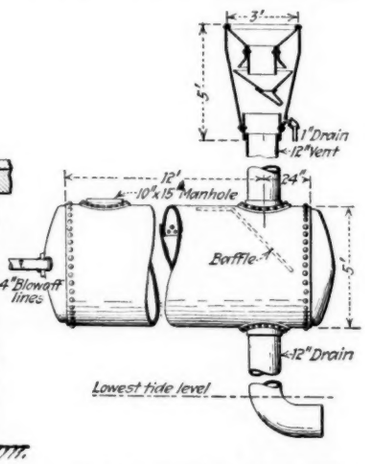


FIG. 2—DETAIL OF TANK AND EXHAUST HEAD

head was made throughout of No. 16 galvanized iron, properly braced and riveted.

The tank was finally suspended under the wharf as shown by four 1⅛-in. galvanized iron U-bolts and braced with saddle blocks.

Every three months the cover is removed and the tank cleaned and painted, inside and out. The blowoff piping is also scraped and given a coat of red lead, and when thoroughly dry a coat of black corrosion-resisting compound is applied. This keeps the pipes and tank in good condition. CLAUDE C. BROWN.

Crockett, Calif.

Drying Out an Induction Motor

A 25-hp. induction motor was flooded with water, and before putting it back into service it was necessary to dry the windings out. To do this, it was decided to use heated air, taking the air from a line where the pressure was about 100 lb. per sq.in. To do the heating, a piece of 4-in. pipe about 4 ft. long, was capped on each end, the center of one cap threaded for a ½-in. pipe

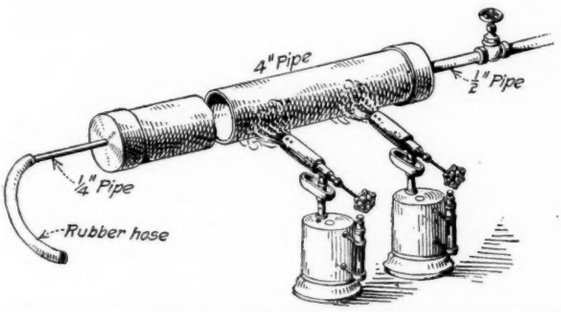


FIG. 1—METHOD OF HEATING AIR FOR DRYING OUT THE MOTOR WINDINGS

and the other for a ¼-in. pipe, as indicated in Fig. 1. One end of the cylinder was connected to the air line and the other to a short piece of ¼-in. pipe to which a rubber hose was attached, the hose being used for leading the air to the motor.

For heating the air as it passed through the 4-in. cylinder, two blow-torches were used. The flow of air was adjusted by the valve in the pipe line, which was not much more than cracked. To retain as much of the heat as possible from the torches on the cylinder, a sheet-asbestos cover was used. The end of the hose was inserted into openings in the motor frame and the air allowed to blow over the windings from one location for 15 or 30 minutes, and then the hose was shifted to a new position. In this way the motor was dried out in 12 hours so that only 5 volts throw was obtained on a

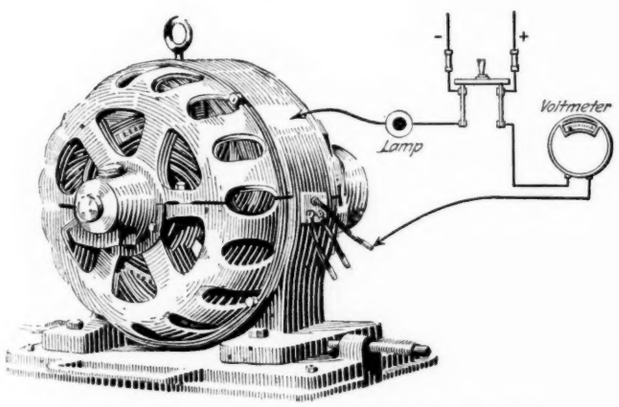


FIG. 2—TESTING INSULATION RESISTANCE

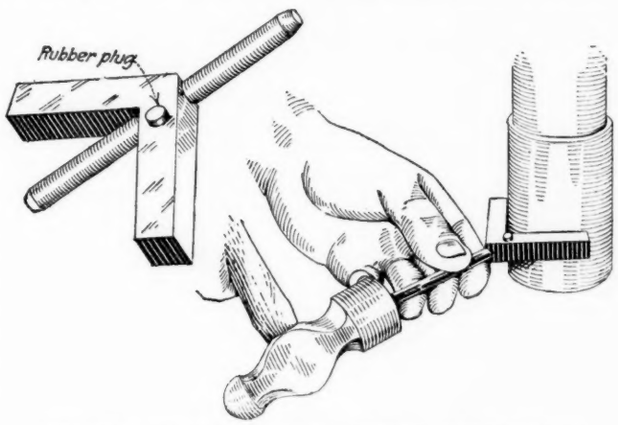
voltmeter having a 300-volt range when connected to one side of a 240-volt line and the motor windings with the other side of the line connected to the motor frame with a lamp in series as in Fig. 2. In figuring the insulation resistance, the formula $R = \frac{(E - e)\ r}{e}$ was used, in which R is the insulation resistance, E the line volts, e the voltmeter reading and r the resistance of the voltmeter. When the resistance of a standard type of direct-current voltmeter is not known, it may be taken as 100 ohms per volt range of the instrument, or in this case the meter had a 300-volt range so that its resistance was taken as 300 × 100, or 30,000 ohms. Using this value for the voltmeter resistance makes $R = \frac{(240 - 5) \times 30{,}000}{5} = 1{,}410{,}000$ ohms. This is well within the same limit, which is considered to be 1,000,000 ohms (one megohm).

A. A. FREDERICKS.
New York City.

Guide for Punch When Removing Small Pins

A handy tool for driving out small pins with protruding ends, from round stock such as collars and shafts, is shown in the illustration.

The tool is made by bending a piece of ½-in. square stock at right angles and drilling a hole in the center of the bend to take a punch made of drill rod. A second hole is drilled at right angles, with the side breaking through slightly. Into this hole is fitted a rubber plug, and this prevents the punch from rebound-



RUBBER PLUG PREVENTS PUNCH REBOUNDING OR DROPPING OUT

ing when struck and also provides a simple means of keeping the parts together when not in use. This tool is especially useful when the pin is located in a position where it is difficult to steady the punch with the hand.

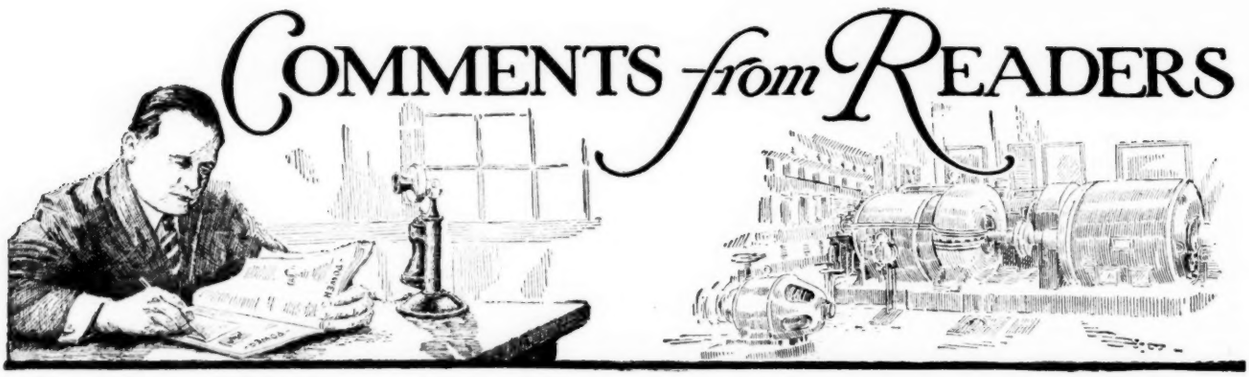
Montreal, Que., Canada. HARRY MOORE.

The Cost of Boiler Compounds

With a view to determining the cost of boiler compounds for use with Lake Michigan water, and basing the cost on 30,000 lb. evaporation as a unit, I have tried out eight different compounds and compared them by general results obtained, with regards to cleanliness in the boiler.

The compound is purchased on the open market, a barrel at a time, at prices varying from 9c. to 17c. a pound. The demand on the boiler plant is about 22,000 lb. of steam an hour in the summer and averages around 75,000 lb. an hour in the winter. The cost varies from 9c. to 22c. on this basis. This gives an average of 11.6c. for each 30,000 lb. of steam or approximately 0.4c. per 1,000 lb. of steam.

Chicago, Ill. C. W. NAYLOR, Chief Engineer, Marshall Field & Company.



Why the Consulting Engineer Should Design the Power Plant

With as many good reasons for employing a consulting engineer to design power plants as given by Mr. Marsh in the Sept. 19 issue, it would seem almost criminal that anyone should do otherwise if it were not for the points Mr. Marsh does not mention. It may as well be admitted at the start that these are the fault of the individual engineers rather than of the system of employing a consulting engineer, but they appear to be so general that they seem to be considered part of the system, and it is well that engineers should consider them and their proper remedies.

First comes the question of choosing a consulting engineer. The average plant owner's acquaintance can do little to recommend him to a competent man. Furthermore, comparatively few places have the safeguard of a state licensing board, and in some instances where there are such boards this safeguard is illusive, as no adequate investigation of the applicant's qualifications is made before registering him. Again, no penalty is provided for men signing themselves mechanical or electrical engineers, or what they choose, regardless of their qualifications, thus making it difficult for the ordinary business man to distinguish between the glib salesman who has branched out into consulting work and the trained and competent engineer.

Even when the fairly competent man has been found, the troubles are by no means over, for not only is the average consulting engineer often superficial in making his investigations of the problems to be met, but his solutions are likely to be cut and dried in accordance with what he terms good engineering practice, and are not submitted for comment and suggestions to the men who must ultimately work with the equipment. The average operating force may not be competent to design a new plant, but they can furnish the designer with valuable information about the characteristics of the load and equipment and can point out changes in proposed plans that will materially increase the convenience and ease of handling and decrease the cost of maintenance. The average consulting engineer is without operating training and is too likely to cramp working space and reduce accessibility and ventilation to make an attractive showing in first cost.

Having a rather wide experience in a large number of power plants during the last fifteen years, the writer is inclined to believe that the average plant contemplating extensive changes, will do best by employing a young, intelligent engineer, putting him to work in the regular operation of the plant, but with opportunity to collect the necessary data. Furnish him with all available information as to future plans, let him discuss from time to time with foremen and workmen or anyone else the difficulties met with in plant operation, give him an opportunity to visit other plants and keep in touch with the progress made in plant design. From this he will compile a tentative schedule or specification of the essentials of the new work. After this has been thoroughly discussed by all concerned, from the foremen up to the management, submit the final plan to one or more of the contracting engineering organizations for a proposal for carrying out the work in concrete form. In this way all the peculiar requirements of that particular business will have the fullest possible attention, the engineer will be more vitally interested in having every detail exactly fitted to its operating conditions and a better check on the proper proportioning of all elements entering into the construction will be obtained than in any other way.

If all consulting engineers lived up to Mr. Marsh's prospectus, there would be little room for argument on his recommendations, but the results obtained, particularly in plant additions, seem to show that some change is necessary whereby the customer will have a more thorough check on what is being done. For this reason the foregoing solution, which has worked out satisfactorily in several cases and at reasonable cost, is suggested.

H. D. FISHER.

Swarthmore, Pa.

Flywheel Explosions and Their Prevention

The article by E. B. Tolsted on page 586 in the Oct. 10 issue contains some good information regarding the safe operation of wheels. A number of statements, however, have been made which may leave an incorrect impression.

The author points out in his article that the solid cast-iron wheel can operate with a peripheral speed of 6,100 ft. per min. and "still have a factor of safety of 10." He does not state the tensile strength he assumed for cast iron and also ignores the fact that practically all solid wheels have inherent stresses caused by unavoidable shrinkage even when produced by some of the best foundries.

In the third paragraph he points out that a solid wheel can be used only if its diameter is less than 10 ft. In a later paragraph, however, he considers the relative chances the operating engineer would have of safely shutting down an overspeeding engine if it was equipped with a solid wheel rather than a flanged

jointed wheel. In my opinion this supposition is absurd from an operating point of view, because insurance records show that few engines have been saved when given the opportunity to run away without load, although many an operating engineer has met his death in the endeavor. The correction for this condition is the installation of an automatic independent speed limit stop on all engines having unreliable governors.

The author bases his formulas for finding factors of safety on the assumption that "the flywheel is a ring revolving in space," the arms having no stiffening effect. As long as this condition obtains, the assumption is correct. When, however, the flanged joint located midway between adjacent arms is considered, the pure "hoop tension" is destroyed by the centrifugal force introduced by the weight of the flanged joints and the bolts holding the halves of the wheel together. As soon as this factor is injected into the problem, the stiffening effect of the arms on the rim further complicates the matter, the sections of the rim between the flanges and adjacent arms becoming beams supported at one end.

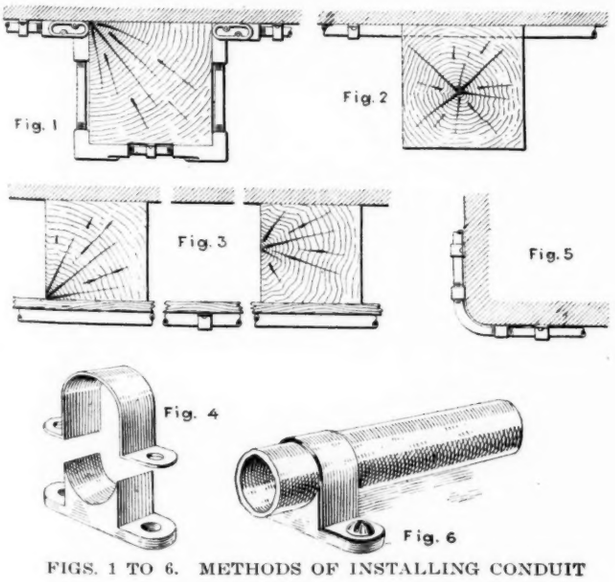
This difficulty has been successfully overcome by more modern designs in which the wheel is split through adjacent arms and the halves held together by the usual hub and rim bolts, and rim links where unusual strength is necessary.

The author apparently has completely ignored this type of wheel, which is becoming common with the development of unaflow and Diesel engines. Furthermore, if he will calculate the theoretical strength of the average wheel of this type as manufactured at the present time, he will find that some of his assumptions and assertions regarding the so-called "link-jointed wheel" are incorrect. J. W. MELROY.

Newark, N. J.

Installation of Metal Conduit

At different times there has been published in *Power* discussion on how to install conduit around a beam by



FIGS. 1 TO 6. METHODS OF INSTALLING CONDUIT

the use of condulets, as indicated in Fig. 1. In this case, if the beams were not too numerous I would recommend drilling a hole through them and placing the conduit against the ceiling, as in Fig. 2. It is also practicable to place the conduits on planks which are fastened between the beams, as shown in Fig. 3. If the conduit is installed in a wet place, it is a good plan to support it by means of distance clips in order to prevent the accumulation of water between the piping and the walls

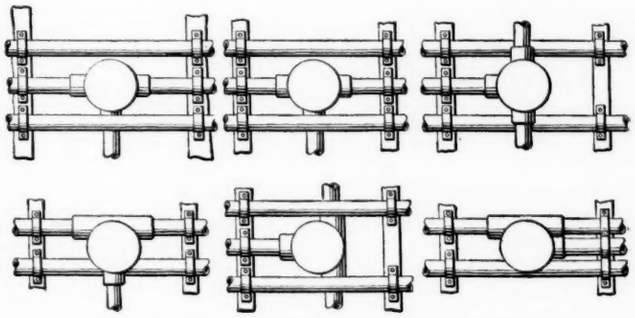


FIG. 7. SPECIAL TYPES OF CONDUIT BOXES THAT ALLOW INSTALLING ALL CONDUITS IN THE SAME PLANE

or ceiling. Such a special clip is shown in Figs. 4 and 6. As to bending around square corners, we in Holland prefer the use of standard bends. These will require cutting away the wood or plaster at the corner (see Fig. 5) unless these bends are to be had in smaller sizes and radii when distance clips are used.

No offset is necessary in the conduit when coming into a junction box where the openings are located just above the bottom of the box and no locknuts are used. Some applications of a special make of box are shown in Fig. 7. No bends need to be made whether standard or distance clips are used, because the openings are specially located in the top or bottom side of the box in order to allow placing the piping in the same plane, as indicated in the figure.

In case all the wires cannot be pulled into one pipe, which often depends upon the regulations of the local company, part of them are inserted in a second pipe. These pipes are fastened by means of double clips and eventually connected to a junction box with a double opening. The boxes are made for any special purpose, but are rather expensive, and that is the reason we prefer the standard fittings, even though it may require a little more work to install them.

Schoonhoven, Holland. H. WIELAND LOS.

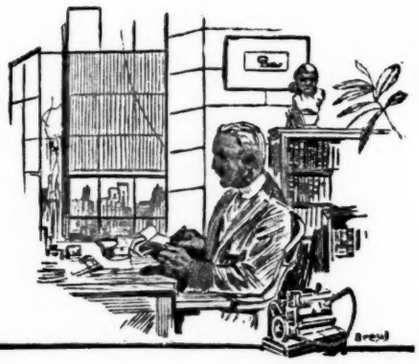
Welding Tubes into the Tube Sheets of Boilers

I read with a great deal of interest the article by Fred. H. Williams in the Oct. 10 issue, on "Welding Tubes into the Tube Sheets of Boilers." As this process is unusual and is entirely new to me, the following questions come up as to the practicability of this method of securing tubes in a sheet.

First, what is the object of welding the tubes into the sheet? Second, how are they welded in without setting up stresses in the sheet? Third, how would you determine whether you had stressed the plate or not? Fourth, when it becomes necessary to replace a welded tube how do you go about it? Fifth, how many tubes could be replaced in the same tube hole without a weakening of the sheet? I would like to see some discussion in *Power* on this subject. L. JOHNSON.

Exeter, N. H.

QUESTIONS AND ANSWERS



Hard Solder for Repair of Lubricator

For repairing a lubricator part, what soldering material can be used that will be stronger than ordinary half-and-half solder? R. C. M.

Where brazing or silver solder would not answer on account of the high temperature required, greater strength than that of common tin and lead solder is obtained by using pure tin. For small work a liquid flux can be made by dissolving rosin in alcohol. A paste flux may be made by rubbing chloride of zinc powder into a thick paste with vaseline.

Cause of Trap Failing to Discharge

When a tilting trap dumps or tilts from the weight of water in the trap, what would be the reason for failure of the water to be discharged from the trap? T. M.

The trap would fail to discharge either from stoppage of the discharge connections or from more back pressure on the discharge than the pressure maintained within the trap. The latter condition would exist if the trap received the condensate from a vacuum system with the discharge open to the atmosphere; or if the pressure of returns received from a heating system were insufficient to overcome the pressure required for overcoming friction of flow plus the pressure against which final discharge must take place.

Measuring Piston-Travel Clearance

What is the method of finding the linear measure of clearance of an engine? J. S. C.

Unless otherwise specified, the term clearance of an engine is understood to apply to the volume of space contained in the cylinder from the piston to the valve seats when the piston is at the end of its stroke; or the term "clearance" is sometimes intended to apply to mechanical clearance, or the distance the piston could be moved beyond the end of the stroke before it would strike against the head of the cylinder or other obstruction. Mechanical clearance is sometimes called "piston-travel clearance" to distinguish it from clearance volume. To obtain the linear measure of piston-travel clearance at either end of the stroke, place the crank on dead center for the same end of the cylinder and make a mark on the crosshead to correspond with a mark made on one of the guides. Disconnect the connecting rod from the crankpin or crosshead and move the crosshead until the piston is brought up hard against the head or other obstruction in the same end of the cylinder. Then the distance the mark on the crosshead has moved past the mark previously made on the guide will be the linear measure of piston travel clearance.

Noise in High-Speed Turbine Stuffing Box

The shaft gland of a small high-speed turbine that is provided with soft braided metallic packing, occasionally produces a slight popping noise. I tightened the gland slightly with the result that packing became very hot. What would you advise as to the cause of trouble? W. F. W.

The noise you mention is caused by drops of water coming through with the steam. These are sometimes re-evaporated by frictional heat and produce an explosive sound. This is perfectly normal and indicates no trouble, usually occurring when glands are tight and in good condition, and gradually disappearing in time.

If avoidable, the shaft packing should not be tightened while the machine is at full speed, as a slight excess of friction will quickly result in heating. Tightening should be done when the turbine is at low speed, so that tight spots can be worn out or forced into proper adjustment without causing excessive heating.

Weight of Discharged Chimney Gases

If a ton of carbon is burned in a furnace using 20 lb. of air per pound of fuel, how many pounds of carbon dioxide, free oxygen and nitrogen would be discarded up the chimney, assuming that the rare gases are classed with the nitrogen? R. L. T.

A ton of carbon would be 2,000 lb. To burn a pound of carbon to CO_2 requires 2.66 lb. of oxygen. Hence in burning 1 lb. of carbon to CO_2 we send up the chimney 1 lb. of carbon + 2.66 lb. of oxygen = 3.66 lb. of CO_2, and for 2,000 lb. of carbon there would be 2,000 × 3.66 = 7,320 lb. of CO_2 discharged up the chimney.

Air contains 0.23 parts by weight of oxygen and 20 lb. of air would contain 20 × 0.23 = 4.6 lb. of oxygen, so that the total oxygen supplied to burn 2,000 lb. of carbon would be 2,000 × 4.6 = 9,200 lb. of oxygen. But as combustion of the carbon required only 2,000 × 2.66 = 5,320 lb. of oxygen there would be 9,200 — 5,320 = 3,880 lb. of free oxygen discharged up the chimney.

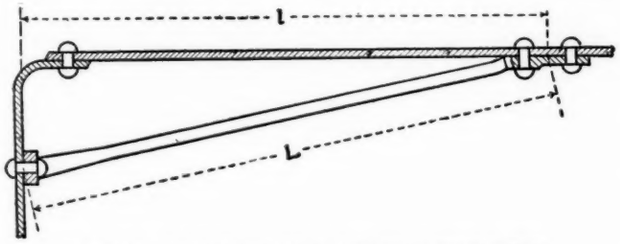
As air contains 0.77 parts nitrogen by weight, there would be 2,000 × 20 × 0.77 = 30,800 lb. of nitrogen received and discharged up the chimney.

Size Required for Diagonal Stay

What should be the size of diagonal boiler stays that would be 5 ft. 6 in. long and riveted to the shell 4 ft. 6 in. from the heads to replace a 1-in. through stay? A. B.

To find the cross-sectional area required for a diagonal stay, multiply the area of a direct stay required

to support the surface by the slant or diagonal length of the stay and divide this product by the length of a line, drawn at right angles to the surface supported to the center of the palm of the diagonal stay. The



MEASUREMENTS FOR DETERMINING SIZE OF DIAGONAL STAY

quotient will be the required cross-sectional area of the diagonal stay, as expressed by the formula,

$$A = \frac{a \times L}{l},$$

where

A = Cross-sectional area of diagonal stay in square inches;
a = Cross-sectional area of direct stay in square inches;
L = Length of diagonal stay as indicated in the sketch, inches;
l = Length of line drawn at right angles to the boiler head to the center of palm of the diagonal stay as indicated in the sketch, inches.

As the equivalent direct stay is 1 in. diameter, a = 0.7854 sq.in., L = 5 ft. 6 in. = 66 in.; and l = 4 ft. 6 in. = 54 in., by substituting the formula becomes

$$A = \frac{0.7854 \times 66}{54} = 0.9599 \text{ sq.in.}$$

for the cross-sectional area of the diagonal stay, requiring $\sqrt{\frac{0.9599}{0.7854}} = 1.1$ diameter.

Vibration of a Turbine Set Caused by Loose Joint in Generator Field

An alternating-current turbine set has run satisfactorily for several years. We recently reconnected the fields to operate on 125-volt exciting current, instead of 250 as formerly and lately have carried a heavy overload with low power factor, when vibration spells have developed. This is in the generator only. We cannot find any ground or other indications of electrical trouble, and the rotating field is aligned centrally with the armature. The set will run for hours perfectly when the generator is not in use, but vibration develops soon after load is applied. What causes the vibration?

W. L. T.

The trouble appears to be due to a loose joint or terminal of one of the generator field coils, which under certain circumstances forms a make-and-break contact, causing a variable magnetic pull in one coil. Probably a terminal or joint was not soldered properly and the excessive field current carried on account of overload and low power factor caused a connection to give way. It sometimes happens that terminals become loose in this manner and are difficult to detect, since the trouble may occur only at certain load conditions when heating is sufficient to destroy proper mechanical contact. It may be possible to locate such a joint by exciting the field and taking the drop of potential across each joint with a multi-voltmeter. The bad joint will show an excessively large voltage drop when compared to the others.

Pressure Plate Valve

What is the purpose of providing an engine valve with a pressure plate, and what are the advantages of a pressure plate valve over the ordinary D-slide valve?

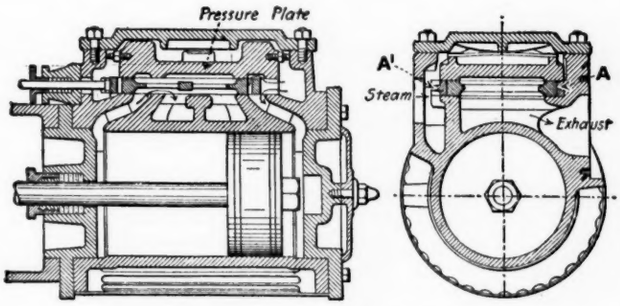
W. F. P.

The friction of an unbalanced D-slide valve depends on the total pressure between the valve and seating and varies with the position of the valve relatively to the ports and on the coefficient of friction which depends on the state of lubrication of the surfaces. The friction involves a considerable waste of power and makes this type of valve an impractical form for control by a shaft governor. Theoretically, the flat-seated slide valve can be relieved of all pressure on the back by changing it to the cylindrical form, thus obtaining what is known as a piston valve. But two essential properties of the flat valve are lost by this change, for the valve is no longer kept to its seat by the steam pressure and cannot lift off its seat against the steam pressure to allow trapped water to escape.

The flat valve with pressure plate combines the balanced feature of the piston valve and the "lifting" permitted by the ordinary slide valve.

By making the valve without a back—that is, like a gridiron—and causing the valve to operate between the valve seat and a stationary back or plate that can be held in place so there will be little or no leakage, the valve can be relieved of pressure against the seat like a piston valve.

A double-ported flat valve with pressure plate is illustrated in the figure. A flat valve slides between the valve face on the cylinder and the pressure plate which is supported by distance pieces A' and A on each side of the valve. The pressure plate is held down with enough pressure to insure sufficient bearing on the



DOUBLE-PORTED BALANCED VALVE WITH PRESSURE PLATE

packing strips to prevent leakage by a flat spring that reacts against the under side of the steam chest cover.

Wear of the valve faces is compensated by reducing the width of the distance pieces, by which means any desired clearance may be obtained between the valve and pressure plate. In some forms of pressure-plate valves the distance pieces are wedge-shaped longitudinally with corresponding seats on the pressure plate and the distance pieces are movable endwise for adjusting the space for the valve between the faces of the cylinder and pressure plate.

Second Revision of the A.S.M.E. Boiler Code

THE following proposed revisions are in continuation of those given in the Oct. 17 issue of *Power*. As there stated, the Boiler Code Committee desires the widest possible discussion of these revisions before they are voted upon at the annual meeting of the A.S.M.E. early in December. Comments may be mailed to C. W. Obert, Secretary to the Boiler Code Committee, 29 West 39th St., New York City. *Power* will also gladly open its columns for letters of general interest dealing with these revisions.

In the following revisions all added matter appears in small capitals (LIKE THIS) and all deleted matter in italic type (*like this*). The deleted matter is also shown inclosed in brackets.

PAR. 243 IN THE CONSTANT C FOR MORISON FURNACES. CHANGE TO READ AS FOLLOWS:

C = 15,600 a constant for *Morison furnaces*, when corrugations are not MORE [*less*] than 8 in. from center to center and the radius of the outer corrugations is not more than one-half that of the suspension curve.

PAR. 244 REVISED:

244. The thickness of a corrugated or ribbed furnace shall be ascertained by actual measurement BY THE FURNACE MANUFACTURER BY GAGING THE THICKNESS OF THE CORRUGATED PORTIONS. IF A HOLE IS DRILLED THROUGH THE SHEET TO DETERMINE THE THICKNESS IT SHALL BE $\frac{3}{8}$ IN. WHEN THE FURNACE IS INSTALLED THE HOLE SHALL BE LOCATED BENEATH THE BOTTOM OF THE GRATE AND CLOSED BY A PLUG. The furnace shall be drilled for a $\frac{1}{4}$-in. pipe tap and fitted with a screw plug that can be removed for the purpose of measurement. For the Brown and Purves furnaces, the holes shall be in the center of the second flat; for the Morison, Fox and other similar types, in the center of the top corrugation, at least as far in as the fourth corrugation from the end of the furnace.

PAR. 247 REVISED:

247. Where NO RULES ARE GIVEN AND it is impossible to calculate with a reasonable degree of accuracy the strength of a boiler structure or any part thereof, a full-sized sample shall be built by the manufacturer and tested to destruction in the presence of the Boiler Code Committee or one or more representatives of the Boiler Code Committee appointed to witness such test. IN SUCH A STEEL-PLATE OR CAST-STEEL STRUCTURE, THE PRESSURE CORRESPONDING TO THE YIELD POINT SHALL BE ACCURATELY DETERMINED AND THE MAXIMUM ALLOWABLE WORKING PRESSURE SHALL NOT EXCEED THAT OBTAINED BY DIVIDING THIS PRESSURE BY 2.5. SUCH STRUCTURES WHEN OF CAST IRON SHALL BE TESTED TO THE BURSTING POINT.

PAR. 250 REVISED:

250. A fire-tube boiler WITH TUBES UNDER 5 IN. DIAMETER shall have [*both ends of*] the tubes [*substantially*] rolled and beaded, or rolled and welded at the firebox or combustion-chamber end, AND ROLLED AND BEADED AT THE OTHER END. IN THE CASE OF TUBES UNDER $1\frac{1}{4}$ IN. DIAMETER, THE TUBES MAY BE EXPANDED BY THE PROSSER METHOD IN PLACE OF ROLLING. IN THE CASE OF TUBES 5 IN. IN DIAMETER AND OVER, THE TUBES SHALL BE SECURED BY RIVETING OR OTHER APPROVED METHOD AT BOTH ENDS.

PAR. 252 REVISED:

252. The ends of all tubes, suspension tubes and nipples of water-tube boilers and superheaters shall project through the tube sheets or headers not less than $\frac{1}{4}$ in. nor more than $\frac{1}{2}$ in. before flaring. WHERE THE TUBES ENTER AT AN ANGLE, THE MAXIMUM LIMIT OF $\frac{1}{2}$ IN. SHALL APPLY ONLY AT THE POINT OF LEAST PROJECTION.

PAR. 253 REVISED:

253. *Drilling of Holes.* All rivet holes and staybolt holes and holes in braces and lugs shall be drilled [*full size*] or they may be punched not to exceed $\frac{1}{4}$ in. less than full diameter for material over $\frac{5}{16}$ in. AND NOT EXCEEDING $\frac{5}{8}$ IN. in thickness, and $\frac{1}{8}$ in. less than full diameter for material not exceeding $\frac{5}{16}$ in. in thickness [*and then drilled or reamed to full diameter.*] FOR FINISHING THE RIVET HOLES, THE plates, butt straps, braces, heads and lugs shall be firmly bolted in position by tack bolts for FINAL drilling or reaming TO FULL DIAMETER [*all rivet holes in boiler plates except those used for the tack bolts.*] THE FINISHED HOLES MUST BE TRUE, CLEAN AND CONCENTRIC. HOLES SHALL NOT BE PUNCHED IN PLATE OVER $\frac{5}{8}$ IN. THICKNESS.

PAR. 254 REVISED:

254. After drilling or reaming rivet holes the plates and butt straps OF LONGITUDINAL JOINTS shall be separated, the burrs and chips removed, the plates and butt straps reassembled metal to metal with barrel pins fitting the holes, and with tack bolts.

PAR. 256 REVISED:

Rivets shall be SO DRIVEN AS [*machine driven wherever possible with sufficient pressure*] to fill the [*rivet*] holes PREFERABLY BY A MACHINE WHICH MAINTAINS THE PRESSURE UNTIL NO PART OF THE HEAD SHOWS RED IN DAYLIGHT [*and shall be allowed to cool and shrink under pressure.*] Barrel pins fitting the holes and tack bolts to hold the plates firmly together shall be used. A rivet shall be driven each side of each tack bolt before removing the tack bolt.

PAR. 259 REVISED:

259. A manhole reinforcing ring when used, shall be of steel or wrought-iron, and shall be at least as thick as the shell plate THICKNESS REQUIRED BY PAR. 180.

PAR. 260 REVISED:

260. Manhole frames on shells or drums when used, shall have the proper curvature, and on boilers over 48 in. in diameter shall be riveted to the shell or drum with two rows of rivets, which may be pitched as shown in Fig. 21. The strength of manhole frames and reinforcing rings shall be at least equal to the tensile strength (REQUIRED BY PAR. 180) of the maximum amount of the shell plate removed by the opening and rivet holes for the reinforcement on any line parallel to the longitudinal axis of the shell through the manhole, or other opening.

PAR. 265. CHANGE CENTER HEADING ABOVE THIS PARAGRAPH TO:

WASHOUT [*holes*] OPENINGS

PAR. 268 REVISED:

268. *Threaded Openings.* ALL PIPE THREADS SHALL CONFORM TO THE AMERICAN PIPE STANDARD AND ALL [*a pipe*] connections 1 in. in diameter or over shall have not less than the number of threads given in Table 8.

If the thickness of the material in the boiler is not sufficient to give such number of threads, the opening shall be reinforced by a pressed steel, cast steel, or bronze composition flange, or plate, so as to provide the required number of threads.

When the maximum allowable working pressure exceeds 100 lb. per sq.in., a NOZZLE OR SADDLE FLANGE [*connection*] riveted to the boiler to receive a flanged fitting shall be used for all pipe openings over 3 in. pipe size.

PAR. 287 REVISED:

287. When the valve body is marked [*with the letters A.S.M.E. Std.*] as required by Par. 273, this shall be a guarantee by the manufacturer that the valve conforms to the details of construction herein specified.

PAR. 294 REVISED:

294. Each boiler shall have three or more gage cocks, located within the range of the visible length of the water glass, except when such boiler has two water glasses with independent connections to the boiler and located on the same horizontal line and not less than 2 ft. apart. LOCOMOTIVE-TYPE BOILERS NOT OVER 36 IN. IN DIAMETER NEED HAVE BUT TWO GAGE COCKS.

PAR. 299 REVISED:

Fittings. Flanged cast-iron pipe fittings including those for steam and for feed water and for pressures not exceed-

ing 160 lb. shall conform to the American Standard given in the Appendix. Where below the water line they shall be extra heavy.

For pressures exceeding 160 lb. per sq.in., fittings more than 2 in. pipe size or equivalent cross-sectional area, shall be of cast or forged steel. (See Pars. 9 and 245.)

For pressures exceeding 250 lb. per sq.in., the flange thickness, and the thickness of the bodies shall be increased to give at least the same factor of safety as the fittings specified in the Table, when used for the maximum pressures permitted in the Code.

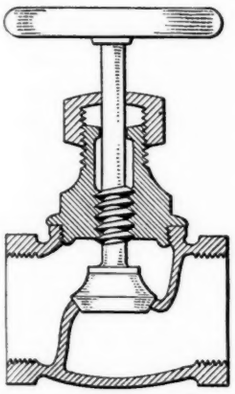


FIG. 22½ (PAR. 308)—TYPE OF GLOBE VALVE

The face of the flange of a safety valve, as well as that of a safety valve nozzle, may be flat and without the raised face, for pressures not exceeding 250 lb. but shall have the raised face for higher pressures.

The number of bolts in a flange may be increased, provided they are located on the standard bolt circle. Other exceptions are noted in Par. 12. Tables 16 and 17 do not apply to flanges on the boiler side of steam nozzles, or to flanges left by the manufacturer as part of the boiler, and do not apply to fittings designed as part of the boiler.

PAR. 303 REVISED:

303. When two or more boilers HAVING MANHOLE OPENINGS are connected to a common steam main, two stop valves, with an ample free-blow drain between them, shall be placed in the steam connection between each boiler and the steam main. The discharge of this drain valve must be visible to the operator while manipulating the valve. The stop valves shall consist preferably of one automatic non-return valve (set next the boiler) and a second valve of the outside-screw and yoke type; or, two valves of the outside screw and yoke type may be used.

PAR. 307 REVISED:

307. *Blowoff Piping.* A surface blowoff shall not exceed 1½ in. pipe size and the internal and external pipes, when used, shall form a continuous passage, but with clearance between their ends and arranged so that the removal of either will not disturb the other. A properly designed brass or steel bushing SIMILAR TO OR EQUIVALENT OF THOSE [*as*] shown in Fig. 22, or a flanged connection, shall be used.

PAR. 308 REVISED:

308. Each boiler shall have a bottom blowoff pipe, fitted with a valve or cock, in direct connection with the lowest water space practicable; the minimum size of pipe and fittings shall be 1 in. and the maximum size shall be 2½ in. STRAIGHTWAY GLOBE VALVES OF THE ORDINARY TYPE AS SHOWN IN FIG. 22½, OR VALVES OF SUCH TYPE THAT DAMS OR POCKETS CAN EXIST FOR THE COLLECTION OF SEDIMENT, SHALL NOT BE USED ON SUCH CONNECTIONS. [*Globe valves shall not be used on such connections.*]

PAR. 311 REVISED:

a. On all boilers except those used for traction and portable purposes, when the maximum allowable working pressure exceeds 125 lb. per sq.in., each bottom blowoff pipe shall have two valves, or a valve and a cock, and such valves, or valve and cock, shall be extra heavy, except that on a boiler having multiple blowoff pipes, a single master valve may be placed on the common blowoff pipe from the boiler, in which case only one valve on each individual blowoff is required. TWO INDEPENDENT VALVES OR A VALVE AND A COCK MAY BE COMBINED IN ONE BODY PROVIDED THE COMBINED FITTING IS THE EQUIVALENT OF TWO INDEPENDENT VALVES OR A VALVE AND A COCK SO THAT THE FAILURE OF ONE TO OPERATE COULD NOT AFFECT THE OPERATION OF THE OTHER.

b. Every traction and portable boiler shall have a bottom blowoff valve; when the maximum allowable working pressure exceeds 125 lb. per sq.in., the blowoff valve shall be extra heavy.

PAR. 314 REVISED:

The feed water shall be introduced into a boiler in such a manner that the water will not be discharged directly against surfaces exposed to gases of higher temperature, to direct radiation from the fire, close to riveted joints of shell or furnace sheets.

PAR. 315 REVISED:

In Fig. 22 is illustrated a typical form of flange for use on boiler shells for passing through piping such as feed, surface, blowoff connections, etc., and which permits of the pipes being screwed in solid from both sides in addition to the reinforcing of the opening in the shell.

PAR. 316 REVISED:

In these and other types of boilers where both internal and external pipes making a continuous passage are employed, the boiler bushing or its equivalent shall be used.

PAR. 318 REVISED:

A BOILER HAVING MORE THAN 500 SQ.FT. OF WATER-HEATING SURFACE SHALL HAVE AT LEAST TWO MEANS OF FEEDING, ONE OF WHICH SHALL BE A PUMP, INSPIRATOR OR INJECTOR. WHERE A SOURCE OF FEED IS AVAILABLE AT A SUFFICIENT PRESSURE TO FEED THE BOILER AGAINST A PRESSURE 6 PER CENT HIGHER THAN THAT AT WHICH THE SAFETY VALVE IS SET TO BLOW, THIS MAY BE CONSIDERED ONE OF THE MEANS. [*When a pump, inspirator or injector is required to supply feed water to a boiler plant of over* 50 *hp., more than one such appliance shall be provided.*]

PAR. 324 REVISED:

A horizontal return tubular boiler 14 FT. OR MORE IN LENGTH, over 54 in. and up to and including 78 in. in diameter, shall be supported by the outside suspension type of setting, or at four points by not less than eight steel or cast-iron brackets set in pairs.

PAR. 325 REVISED:

325. Lugs or brackets, when used to support a boiler of any type, shall be properly fitted to the surfaces to which they are attached. The shearing and crushing stresses on the rivets used for attaching the lugs or brackets shall not exceed 8 per cent of the strength given in Pars. 15 and 16. WHERE IT IS IMPRACTICAL TO USE RIVETS, STUDS WITH NOT LESS THAN 10 THREADS PER INCH MAY BE USED. IN COMPUTING THE SHEARING STRESSES, THE AREA AT THE BOTTOM OF THE THREAD SHALL BE USED. [*For traction or portable boilers, studs with pipe threads may be used.*]

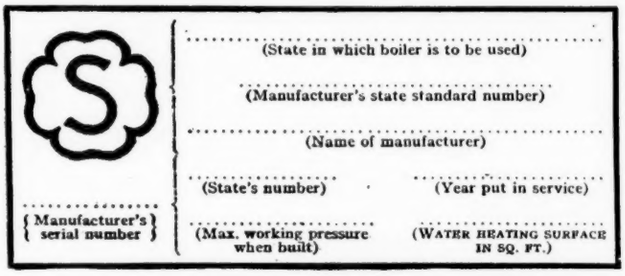

(State in which boiler is to be used)
(Manufacturer's state standard number)
(Name of manufacturer)
(State's number)
(Year put in service)
Manufacturer's serial number
(Max. working pressure when built)
(WATER HEATING SURFACE IN SQ. FT.)

FIG. 24 (PAR. 332)—FORM OF STAMPING

PAR. 332. CHANGE TABULATION AT END OF PARAGRAPH AND FORM OF STAMPING AS FOLLOWS:

1. Manufacturer's serial number.
2. State in which boiler is to be used.
3. Manufacturer's state standard number.
4. Name of manufacturer.
5. State's number.
6. Year put in service.
7. Maximum working pressure when built.
8. WATER HEATING SURFACE IN SQ.FT.

Items 1, 2, 3, 4, 7 AND 8 are to be stamped at the shop where built.

Items 5 and 6 are to be stamped by the proper authority at point of installation.

FIG. 32 REVISED:

A. Change dimension line to center of stayrod.
D. Change dimension line to center of staybolt.
F. Change dimension line to center of door ring rivet.
H. Give eighth sketch in drawing the designation "H."

PAR. 423. CHANGE SECOND SECTION TO READ AS FOLLOWS:

A bevel-seated 3½-in. valve WITH [*is marked by the manufacturer*] 0.11 in. lift HAS A [*and*] discharge capacity AT [*for*] 100 lb. pressure OF [=] 4,840 lb.; hence two such valves would be required.

PAR. 424. CHANGE SECOND SECTION TO READ AS FOLLOWS:

A bevel-seated 2½ in. valve WITH [*is marked by the manufacturer*] 0.08 in. lift HAS A [*and*] discharge capacity AT [*for*] 275 lb. pressure OF [=] 6,350-lb.; hence two such valves would be required.

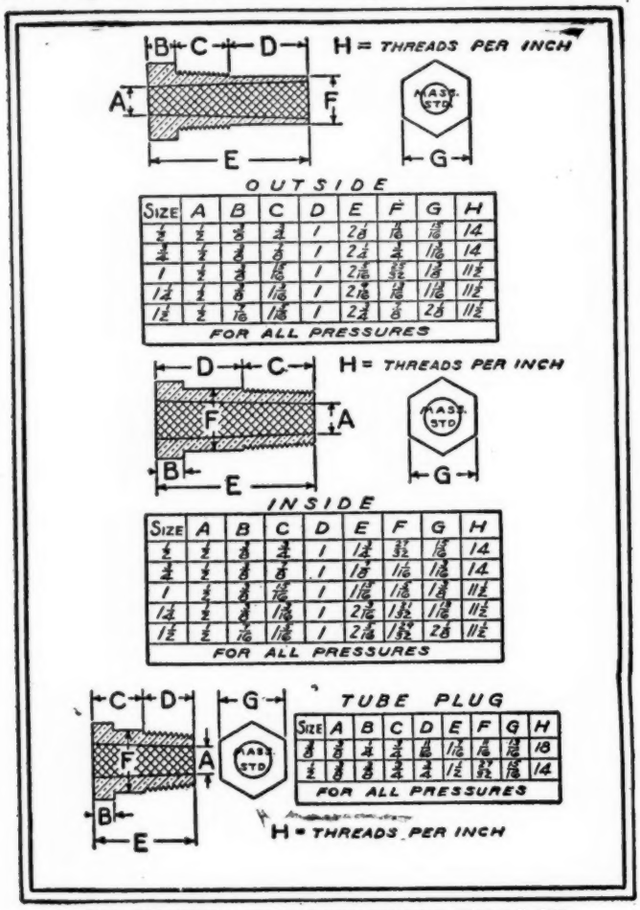


FIG. 33½ (PAR. 428)—ACCEPTABLE FORMS OF FUSIBLE PLUGS

PAR. 425. CHANGE SECOND SECTION TO READ AS FOLLOWS:

A bevel-seated 2-in. valve WITH [*is marked by the manufacturer*] 0.11 in. lift HAS A [*and*] discharge capacity AT [*for*] 150 lb. pressure OF [=] 2,500 lb.; hence one such valve would be required.

TABLE 16. CHANGE TITLE TO READ AS FOLLOWS:

AMERICAN STANDARD 125-LB. WORKING PRESSURE PER SQ.IN. STANDARD CAST-IRON FLANGE FITTINGS, STRAIGHT SIZES (SEE FIG. 33).

TABLE 17. CHANGE TITLE TO READ AS FOLLOWS:

AMERICAN STANDARD, 250-LB. WORKING PRESSURE PER SQ.IN., EXTRA HEAVY CAST-IRON FLANGE FITTINGS, STRAIGHT SIZES (SEE FIG. 33).

PAR. 428 REVISED:

428. Fusible plugs, if used, shall be filled with tin with a melting point between 400 and 500 deg. fahr., and shall be renewed once each year. WHERE THE BOILERS ARE TO BE OPERATED AT WORKING PRESSURES IN EXCESS OF 225 LB. PER SQ.IN. GAGE, THE USE OF FUSIBLE PLUGS IS NOT ADVISABLE.

Generator Station Development

BY D. B. RUSHMORE AND E. PRAGST

After reviewing the general trend in power development and transmission for the last twenty to thirty years at the annual convention of Association of Iron and Steel Electrical Engineers the authors say "In the case of turbo-generator development, confining ourselves to the advance made in this country, which is representative of that throughout the world, and speaking particularly of single-shaft units of the Curtis design, a steady development is recorded, culminating in the highly reliable and economical units of the present. During 1903 a 5,000-kw. unit was built. This was the largest up to that time. During 1911 the capacities of units had gradually increased to 20,000 kw. In 1917 the installation of a 45,000-kw. unit was witnessed, the largest single-shaft machine constructed in this country to date (Germany is credited with a 50,000-kw. machine). During fourteen years the capacities of turbo-generators has risen from 5,000 to 45,000 kw., or an eightfold increase.

To better station economies steam pressures and superheat have been gradually increased and turbine design improved to utilize effectively the maximum vacuum available with the cooling water at hand. With a rise in steam pressures and temperatures and a betterment of vacuum, which have increased the range of the heat cycle, making available for conversion into mechanical energy an added amount of power, has come an increase in turbine thermal efficiency through improvements in design. The water rate of present large machines is less than half that of the early large units. The increase in thermal efficiency of these large turbo-generators has steadily risen from 14.3 to 27 per cent.

During the last two or three years developments in turbines have been more pronounced than during any other equal period and perhaps even more than that shown by any other of the important pieces of apparatus used in power generation. Confining ourselves to the Curtis type turbine as manufactured by the General Electric Co., improvements applied to machines in service and in the course of construction and in general to the larger rather than the smaller units, the more important developments may be enumerated as follows:

A. Improvements in methods of design.
B. Improvements in methods of manufacture.
C. Development and use of more suitable materials for parts in contact with steam, which makes it possible to extend the range of the heat cycle.
D. Development of designs that result in increased economy.
E. Development of designs that result in greater reliability.
F. Successful culmination of a comprehensive theoretical research, substantiated by experimental proof, into the phenomena of resonance as applied to turbine wheels and the discovery of the laws governing these phenomena. The results of this work are of the most far-reaching character, for they explain the causes for the difficulties experienced under operating conditions with the wheels of a number of large turbines and make it possible to assure, with absolute certainty, a non-recurrence of such trouble.
G. The construction of nozzles has been changed so that, except in the low-pressure stages, the nozzles themselves can be easily removed.
H. Adoption of a labyrinth type of packing with non-corrodible teeth. This type of packing has been subjected to severe rubbing, both experimentally and in service, without appreciably affecting its efficiency.
I. Use of cast steel for valve casings, turbine heads and those parts of the turbine shell subject to extreme temperature changes.
J. Experiments with non-corrodible metals for buckets have led to the use of Monel metal so far as the physical properties of the metal and stresses permit.
K. The magnetic exploration of wheel forgings for the purpose of locating hidden defects, such as slag inclusions, seams and other injurious defects, is now standard practice.

*Consulting engineer and engineer, respectively, General Electric Co.

News in the Field of Power

Potomac Power Company Enlarges Plant

To take care of expanding business, principally domestic lighting, the Potomac Electric Power Co., of Washington, D. C., has appropriated $1,500,000 for 1923 for plant improvement and extension. For several years the company has been spending approximately $1,000,000 for this purpose.

The plant is being changed from 25-cycle for 60-cycle lighting to direct 60-cycle generation. One 12,500-kw. generator is being installed to replace a 9,000-kw. 25-cycle vertical generator and will be in operation in November. Another of the same type, to replace a 5,000-kw. vertical unit, will be ready Jan. 1. Rotary converters are to be installed in the two existing direct-current substations, while a third station, similarly equipped, has been proposed.

The company consumed 29,000 tons of coal in its power plant in 1901 at a cost of $3.41 a ton, whereas in 1921 201,125 tons was burned, at $8.29 a ton. Company records show that while production expense has more than doubled from 1915 to 1921, the cost of current delivered has increased only slightly. In 1915 the delivered cost was 2.545c. per kilowatt, with a production expense of 0.595c. while in the latter year the cost of current delivered was 2.575c. and production expense was 1.217c. Greater distribution, reducing certain items of general expense and overhead, made these figures possible in the face of a 100 per cent increase in coal and a 300 per cent increase in labor costs.

The Potomac company finds that its greatest growth is in 60-cycle or domestic business, which this year has increased about 21 per cent—almost double the rate of increase of a year ago. The railway load is stationary and gives some indication of a small decrease. There is little strictly industrial power used in the District of Columbia, as Washington is not a manufacturing center.

New Water-Power Development in New Hampshire

The Lake Sunapee Power Co., recently incorporated under the laws of New Hampshire, is soon to begin construction on a water-power project at Lake Sunapee, N. H., which will be a considerable addition to the electric energy now available in the southern parts of Vermont and New Hampshire.

Work has been started on the foundation for a hydro-electric station at the source of the Sugar River, which is the outlet of the lake. At present the company plans to develop only about 1,500 hp., but this will be increased as the need arises.

The officers of the new company are: president, I. M. Frost, Rutland, Vt.; vice-president, John B. Manley, Brattleboro, Vt.; treasurer, F. P. Murphy, Newport, N. H. The company intends to expend about $300,000 on the project at the start, but with a watershed of over forty-seven square miles and an ever increasing demand for electricity, it is felt that an investment of twice this amount eventually will be called for.

Renews Lease on Sheffield Steam Plant

Realizing that it would be unable to supply the power demands of the Southeast during the coming winter without the assistance of the government steam plant at Sheffield, the Alabama Power Co. has obtained a year's renewal of its lease on that plant, dating from Dec. 1.

"Even with the completion of the Mitchell dam and power plant early next spring," said Thomas W. Martin, president of the company, "our resources would have been inadequate without the Sheffield plant, for in addition to our usual load we are supplying power to other Southern companies whose consumer demands are much in excess of their present capacities, and who will therefore require assistance during the coming winter and for a considerable part of next year."

Brains versus Smoke

Commenting upon the probability that the smoke problem in this country, particularly in the Eastern States, will be increased this winter because of the substitution of grades of coal different from those supplied under normal conditions, O. P. Hood, mechanical engineer of the United States Bureau of Mines, who has just returned from a trip to Europe, declared that while this is unnecessary, there appears to be no immediate means of preventing it because of the usually careless methods of burning fuel in the United States.

"It is entirely possible to burn fuel efficiently without dense smoke," said Mr. Hood. "The solution lies in the use of brains and care, rather than of new devices and attachments. In a few cases devices may be necessary, but not generally.

"Germany uses all sorts of fuel, yet I saw very little smoke in that country. This is not due to any peculiar character of the fuel she uses, but to the admixture of brains and a little more care with the fuel when it is burned.

"Thrift in heat production and use in Germany is absolutely necessary. If for some reason we were compelled to become thrifty, we would have no smoke problem in the United States. It will be found here that as the price of coal advances, the smoke problem will disappear."

Headwater Provision Needed in Water-Power Act

The drafting of a headwater improvement regulation is now being considered by the Federal Power Commission. Such a regulation is needed in cases where two or more power companies are operating on the same stream, in order that all may obtain the best operating conditions. The ideal condition would be to have each river developed by a single concern, but since this is manifestly impossible a plan must be worked out whereby the reservoirs can be operated to the maximum advantage of several projects.

Such a regulation would apply to a large number of streams, among which are the San Joaquin, Mississippi, Columbia, and practically every power-producing river in California. For example, the headwaters of the San Joaquin River have been developed by the Southern California Edison Co. Below this large reservoir system, now partly constructed, the San Joaquin Power & Light Co. has an important plant. The operation of that plant could be materially affected by the handling of the Edison Co.'s system farther upstream.

The Commission's staff is engaging in this work with the idea of setting up certain broad conditions. Conditions vary so widely on different streams that any attempt to go into detail in drafting the regulations would result in an unnecessary burden on water-power development.

Up-to-date Power Laboratory for University of California

Construction has been started on a sorely needed heat and power laboratory, the first unit of a group of buildings for the College of Mechanics at the University of California, Berkeley, Calif. The building will be a one-story reinforced concrete structure, 40 x 100 sq.ft. in floor area.

The equipment chosen is such as to make the laboratory one of the most modern in the country. There will be a 150-hp., 350-lb. experimental steam boiler, fired with either oil or powdered coal and equipped with complete control apparatus and auxiliaries; a 50-hp. marine compound engine with integral condenser; a 25-hp. turbo-generator with condenser; a 75-hp. unaflow engine with condenser; a 15-hp. gas-fired boiler and engine; a semi-Diesel engine; a Westinghouse gas engine; a Frick Corliss engine; a refrigerating plant and an air-compressor plant; four different types of gasoline engines, and the usual auxiliary equipment for fundamental experiments in steam engineering, including four 10,000-lb. automatic water-weighing machines.

May Revoke Preliminary Permits

Because the permittee has failed to carry out the required stream-gaging work and other engineering investigations, two of the preliminary permits issued by the Federal Power Commission will be presented for revocation at the next meeting of the Commission.

In one of these cases the permittee offered the excuse that he has not been able as yet to interest capital in his project, and does not consider it fair for the Commission to require him to spend several thousand dollars of his own money while the outcome of the financing is still in doubt.

The Commission holds, on the other hand, that the permittee must make these expenditures in order to show that his project is at all feasible, and that no reliable financial establishment would consider the financing of a project until the permittee had shown convincing facts as to the availability of a satisfactory water supply. The Commission is anxious to prevent the tying up of water-power resources with those who are not in a position to carry out development.

Practical Refrigerating Engineers To Convene

An opportunity for every refrigeration and ice-making plant executive and engineer to come into contact with others similarly occupied and interested will be afforded at the coming convention of the National Association of Practical Refrigerating Engineers, to be held at the Planter's Hotel, St. Louis, Nov. 1-4.

The program, containing a large number of papers of great educational and practical value, is as follows: "Economics of Refrigerating Plants," by Victor J. Azbe, consulting engineer, St. Louis, Mo.; "Instruction in Refrigeration Engineering," by Prof. F. P. Siebel, president, Siebel Institute of Technology, Chicago, Ill.; "Motor Drive vs. Steam for Ice and Refrigerating Machines," by A. R. Stevenson, Jr., General Electric Co., Schenectady, N. Y.; "Electricity in Refrigerating Plants," by H. L. Semans, Duquesne Light & Power Co., Pittsburgh, Pa.; "Principles and Practical Operation of the Absorption Refrigerating Machine," by Heywood Cockran, Carbondale Machine Co., Chicago, Ill.; "Ammonia as a Refrigerant," by W. H. Motz, technical editor of *Ice and Refrigeration*, Chicago, Ill.; "Measuring Devices for Ice-Making and Refrigerating Plants," by John E. Starr, president Starr Engineering Co., New York City; "The Process of Freezing Ice," by R. H. Hemphill, president Carolina Public Service Co.. Charleston, S. C.; "New Refrigeration Appliances, Apparatus and Processes," by R. H. Tait, consulting engineer, Tait & Nordmeyer Eng. Co., St. Louis, Mo.; "Lubrication of Refrigerating Machinery," by John W. Stack, lubricating engineer, Standard Oil Co., Chicago, Ill.; "Low Pressure Refrigerants," by H. D. Edwards, Carbide & Carbon Chemical Corp., New York City; "High-Speed Ammonia Compressors," by A. J. Hecker, St. Louis Refrigerating & C. S. Co., St. Louis, Mo.; "Steam Boilers and Furnaces for Refrigerating Plants," by W. D. Dunbar, chief engineer, Commonwealth Ice & Cold Storage Co., Boston, Mass.; "Specifications and Contracts for Refrigerating Equipment," by A. C. Bishop, consulting engineer, A. C. Bishop & Co., Cleveland, Ohio; "Ammonia Compressor Valves," by J. H. H. Voss, consulting engineer, New York City; "Economy and Efficiency of the Absorption System for Production of Low Temperatures," by G. A. Pardee, Henry Vogt Machine Co., Louisville, Ky.; "Air Cooling by Mechanical Refrigeration," by J. B. Williams, chief engineer, Triumph Ice Machine Co., Cincinnati, Ohio; "Modern Methods of Harvesting Ice," by R. C. Doremus, refrigerating engineer, Geo. B. Bright Co., Detroit, Mich., and "Air Agitating Systems for Raw Water Ice Manufacture," by H. R. Halterman, general superintendent, Ice Factories Consumers Co., Chicago, Ill.

In addition, there will be discussion of the following topics: Cracked and checked ice; methods of cooling condenser water; practical methods of testing ammonia; welding of equipment in ice-making and refrigerating plants; practical considerations for overhauling and repairing ice-making and refrigerating plants; importance and use of engine room records; practical rules and formulas for the refrigeration engineer; operating engineer's viewpoints of compound compression, and labor requirements for ice plants.

Coming Conventions

The Electric Power Club; S. N. Clarkson, secretary, Kirby Bldg., Cleveland, Ohio. Fall meeting at Asheville, N. C., Oct. 30-Nov. 2.

National Association of Practical Refrigerating Engineers; Edward H. Fox, secretary, 5707 West Lake St., Chicago, Ill. Annual convention and exhibition at St. Louis, Mo., Nov. 1-4.

Society of Naval Architects and Marine Engineers, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 8-9.

American Society of Mechanical Engineers, 29 West 39th St., New York City. Annual meeting at New York City, Dec. 4-8.

American Society of Refrigerating Engineers; W. H. Ross, secretary, 154 Nassau St., New York City. Annual meeting at New York City, Dec. 4-6.

National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York City, Dec. 7-13.

Personals

P. C. Idell, for twenty-three years connected with the engineering and sales departments of the Babcock & Wilcox Co., has been appointed manager of the company's New England office, at 49 Federal St., Boston.

Dr. Charles Russ Richards was inaugurated president of Lehigh University, Bethlehem, Pa., on Founder's Day, Oct. 14.

P. Albert Poppenhusen remains president of the Green Engineering Co., whose stock was taken over on Sept. 28 by the International Combustion Engineering Corp.

Dr. Samuel Wesley Stratton, for twenty-one years director of the Bureau of Standards at Washington, has been elected president of Massachusetts Institute of Technology and will assume the position on Jan. 1. Dr. Stratton was graduated in 1884 from the University of Illinois, where he later became professor of physics and electrical engineering. From 1892 to 1901 he was with the physics department of the University of Chicago. He has received the honorary degree of Doctor of Engineering from the University of Illinois and that of Doctor of Science from Yale, the Western University of Pennsylvania and the University of Cambridge. He was made a Chevalier of the Legion of Honor in 1909.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Oct. 9, 1922	Oct. 16, 1922
Pool 1,	New York	$4.75–5.75	$4.75–5.75
Smokeless,	Columbus	5.50–6.00	4.75–6.50
Clearfield,	Boston	4.00–4.50	4.00–4.50
Somerset,	Boston	4.00–4.60	4.00–4.60
Kanawha,	Columbus	4.00–5.35	4.25–4.75
Hocking,	Columbus	3.25–3.75	3.25–3.75
Pittsburgh No. 8	Cleveland	4.25–4.50	3.50–3.75
Franklin, Ill.,	Chicago	4.25–4.75	4.25–4.75
Central, Ill.,	Chicago	3.25–4.00	3.25–4.00
Ind. 4th Vein,	Chicago	4.50–4.75	4.50–4.75
West Ky.,	Louisville	3.50–3.75	2.75–3.25
Big Seam,	Birmingham	2.60	2.50–3.00
S. E. Ky.,	Louisville	4.00–5.50	3.75–5.00

FUEL OIL

New York—Oct. 19, Port Arthur light oil, 22@25 deg. Baumé, 5c. per gal.; 30@35 deg., 5½c. per gal., f.o.b. Bayonne, N. J.

Chicago — Oct. 14, for 24@26 deg. Baumé, $1.20 per bbl.; 32@36 deg., 3½c. per gal. in tank car, f.o.b. Oklahoma refinery, or freight adjusted.

Pittsburgh—Sept. 12, f.o.b. refinery, Pennsylvania, 36@40 deg., 6¼c.; Kentucky fuel oil, 26@30 deg., 4½c. per gal.; Gas oil, 32@34 deg., 2¾c. per gal.; 36@38 deg., 3c.; 38@40 deg., 3¼c.; Western, 24@30 deg., $1.30 per bbl.

Philadelphia — Oct. 16, 26@28 deg. Baumé, Oklahoma, $1.05@$1.10 per bbl.; 30@34 deg., Oklahoma (group 3). 3@3¼c. per gal.; 16@20 deg. Seaboard, $1.40@$1.50 per bbl.

St. Louis—Oct. 9, f.o.b. Oklahoma 24@26 deg. $1.20 per bbl.; 26@30 deg. $1.20 per bbl. Gas oil 32@34 deg. 3¼c. per gal.

Cincinnati—Oct. 10, for 26@28 deg., Baumé, 5½c. per gal.; 28@30, Diesel, 5¼c.; 38@40 deg., distillate, 6c. per gal.

Cleveland—Oct. 10, for 26@28 deg. Baumé, 4½c. per gal.

New Plant Construction

PROPOSED WORK

Ark., Walnut Ridge—The Central Power & Light Co., is in the market for electrical generating equipment for installation in plant here.

Calif., Crows Landing—The West Stanislaus Irrigation Dist., has had plans prepared for irrigation of about 13,800 acres and 25,000 ft. of canal 24 ft. wide at top and 9 ft. at bottom, concrete lined, also a main pumping station and 4 booster plants. Estimated cost $650,000. E. N. Bryan, Forum Bldg., Sacramento, Engr. Noted Feb. 28.

Calif., Tracy — The Naglee-Burk Irrigation Dist., L. C. Stark, Secy., will receive bids until Nov. 3 for furnishing and installing equipment, including one 12 in. double suction vertical centrifugal pump, with impeller, pump shaft, shaft tubing and coupling, etc., for direct connected motor and companion flange on pump discharge nozzle to connect with 12 in. flanged check valve; one 12 x 18 in. curved taper, flanged and hubbed to fit 18 in. pipe; 1 automatic lubricating attachment for pump; one 30 hp., 60 cycle, 3 phase, 440 volt, 580 revolutions per min.; 40 degree motor with remove control and automatic starting compensator; 1 float switch 37½ kw., 2,200 to 440 volt transformers with necessary oil and hangers; pump to have 4,500 gal. per min. capacity against 20 ft. head, switches, etc., all under Contract 4.

D. C., Wash.—H. Crandell, 934 F St., N.W., is having plans prepared for a moving picture theatre. Estimated cost $500,000. T. W. Lamb, 644 5th Ave., New York, Archt. Equipment detail not reported.

Fla., Miami — The City Comn., F. H. Wharton, Mgr., will receive bids until Nov. 7, for furnishing 1 motor driven sewage screen, including motors and necessary equipment, capacity 2,100 gal. per min.; 2 motor driven centrifugal pumps, including motors and necessary equipment, capacity 2,100 gal. per min. against total head of 30 ft. and 2,400 ft. 16 in. Class B c.i. pipe.

Idaho, Boise — The U. S. Reclamation Service, Denver, Col., will receive bids until Dec. 6 for furnishing 2 direct pumping units for the Black Canyon pumping plant here. M. Bien, Wash., D. C., Acting Dir.

Ill., Chicago—A. S. Alschuler, Archt., 28 East Jackson Blvd., is receiving bids for a 3 story, 100 x 300 ft. candy factory, including steam heating system, on Cicero and Kinzie Sts., for Brach & Sons, 215 West Ohio St. Estimated cost $1,000,000. Noted Sept. 5.

Ill., Chicago—Holabird & Roche, Archts., 104 South Michigan Ave., are receiving bids for a 25 story, 173 x 402 ft. hotel "Stevens," including steam heating system, on Michigan Blvd., for J. W. and E. J. Stevens, c/o Hotel LaSalle. Estimated cost $15,000,000. Noted Mar. 14.

Ill., Marshall—The city council, F. L. Archer, Clk., will receive bids until Nov. 9 for light and power plant improvements, consisting of new power house, 2 a.c. generators direct connected to uniflow engines, switchboard, 2 boilers, piping, chimney, moving and resetting a fire tube boiler, etc.; erecting ice plant building complete, including furnishing and installing ice making machinery, 15 ton per day capacity, distilled water ice plant, etc.; water works, consisting of removing old pumps from existing water works pumping station, furnishing and installing 2 motor driven, triplex pumps of 350 g.p.m. each and furnishing and erecting transmission line including transformers from power house to pumping station, about 1.8 mi., etc. Noted Sept. 19.

Ill., Riverdale—The Chicago & Riverdale Lumber Co. is in the market for a complete d.c electric light plant, belt driven 50 to 60 kw. generator, with switchboard, etc.

Ill., Shelbyville—The city will vote on $100,000 bond issue Oct. 24 for an electric light and power plant, including 45 x 100 ft. power house 30 ft. high, two 200 hp. boilers, two 500 kw. generators, also street lights and wires. W. A. Fuller, 1971 Railway Exchange, St. Louis, Engr. Noted July 25.

Ind., Auburn—The city, G. Potter, Clk., will receive bids until Nov. 2 for the purchase, installation and complete construction of machinery and general equipment for improvement of water works, electric light and power plant as follows: (1) one steam turbo generator 1,000 kw., 1,250 kva., 80% power factor, 2,300 volt, 3 phase, 60 cycle, 3,600 r.p.m., condensing steam turbo generator without exciter; (2) one motor driven exciter, 30 kw. 125 volt, compound wound, d.c. and mounted on one common bed plate and driven by a 220 volt, 3 phase, 60 cycle, synchronous motor sufficient capacity to deliver the full load power required by generator, motor driven exciter to be furnished and erected complete on foundations and supports to be furnished by purchaser; (3) one condenser, low level jet type, with single impeller motor driven removal pump and separate motor driven spray pond pump; (4) one switchboard to control one 2,300 volt, 3 phase, 60 cycle, 1,000 kw. 80% power factor, turbo driven generator and 1 exciter panel to take care of 125 volt, 30 kw. motor driven exciter; (5) 2 centrifugal pumps designed to deliver 695 gal. water per min. against total head of 150 ft. driven by 220 volt, 3 phase, 60 cycle, synchronous motors, complete with flexible coupling and extended base plate to receive motors.

Ind., Mishawaka — The School Board plans to build a 2 story high school. Estimated cost $600,000. Architect not selected.

Ind., Terre Haute—The Vigo Mining Co., Rose Dispensary Bldg., is having plans prepared for the construction of a 1 story, 50 x 80 ft. power house, including four high pressure boilers, motors and steam mine hoisting machinery. Estimated cost $75,000. Shourds-Stoner Co., Tribune Bldg., Archts.

Kan., Topeka—The Topeka Hotel Co. is having preliminary plans prepared for the construction of a 10 story, 75 x 159 ft. hotel, 200 rooms capacity, on 7th and Jackson Sts. Estimated cost $600,000. T. N. Williamson & Co., 312 Central Bldg., Archts. Noted Feb. 7.

Ky., Covington—The Salvation Army, 120 West 14th St., New York, is having preliminary plans prepared for a 4 story addition to hospital here. Estimated cost $250,000. H. D. Chase, 120 West 14th St., New York, Archt. and Engr. Additional equipment not reported.

Ky., Pikeville—The Pike Power & Light Co. plans a $200,000 bond issue for extensions and improvements to its plant and lines.

Mich., Detroit — The Bd. Educ., 1354 Bway. Ave., received bids for a 2 story, 120 x 130 ft. and 67 x 180 ft. school building, including steam heating boiler and accessories, plenum system and mechanical ventilator, on Clinton and Chene Sts., from F. H. Goddard, 2130 Franklin St., $726,192. F. N. Cooper, 6370 Gratiot Ave., $729,885, and Corrick Bros., 507 Owen Bldg., $746,848.

Mich., Grand Haven—Cahill & Douglas, Engrs., 217 West Water St., Milwaukee, is receiving bids for additional equipment, including vacuum pumps, mechanical stokers, V notch meters, voltage regulators and feed water regulators for plants here and at Whitehall, for the Eagle Ottawa Leather Co.

Mich., Lansing—The Lansing Theatre Co., 128 West Allegan St., has had plans prepared for a 10 story, theatre on Capital St. Estimated cost $750,000. S. D. Butterworth, Tussing Bldg., Archt. Equipment detail not reported.

Mo., St. Louis—The Atlas Tack Co., Fairhaven, Mass., is having plans prepared for a plant for the manufacture of tacks and similar products, including a 1 story, 203 x 503 ft. main plant, a 2 story, 25 x 203 ft. office building, two 30 x 67 ft. and 30 x 187 ft. storage sheds and a 20 x 30 ft. transformer house, on Union and Geraldine Sts. Direct radiation plant, including two boilers, will be installed. Owner is in the market for complete equipment for plant, also for sprinklers and transformer to reduce 13,000 kw. line. Estimated cost $400,000. Widmer Eng. Co., Laclede Gas Bldg., Engrs.

Mo., St. Louis—The Bd. Educ., 9th and Locust Sts., is having plans prepared for a 3 story, 410 x 410 ft. North Side high school, including two 350 hp. stoker fed water tube boilers, direct air washer and pumps, 210,000 cu.ft. all blast fan system, tunnel distribution, two 200 and 100 kw. steam watchman and emergency gas generator, etc., on Natural Bridge Ave., estimated cost $1,500,000; is also having preliminary plans prepared for two 3 story, 95 x 220 ft. and 95 x 221 ft. grade schools, including 50,000 cu.ft. plenum systems complete, two 100 hp. low pressure stoker fed boilers each and 20 hp. gas engines each for fans, etc., on Penrose and Arsenal Sts. and Kingshighway, estimated cost $250,000 to $275,000 each. R. M. Milligan, 506 Bd. of Educ. Bldg., Archt. and Engr.

Mo., St. Louis—The Bd. Educ., 9th and Locust Sts., will receive bids until Nov. 8 for two 2 story, 95 x 221 ft. grade schools, "Edward Long" on Morganford Rd. and Walsh St. and the "Cyrus P. Waldbridge" on Davidson and Lilian Aves., equipment includes complete plenum systems, 50,000 cu.ft. capacity, two 100 hp. low pressure stoker fed boilers and a 20 hp. stationary engine for fans and vacuum for each building. Estimated cost $300,000 each. R. M. Milligan, 506 Bd. of Educ. Bldg., Archt.

Minn., Minneapolis—The Fleisher Constr. Co., 606 Builders' Exch. Bldg., is having plans prepared for a 6 story, 138 x 170 ft. apartment building at 3340 West Grand St. Estimated cost $750,000. Vorse, Kraetsch & Kraetsch, 911 S and L Bldg., Des Moines, Ia., Archts. Equipment detail not reported.

Mo., Paris—The city, C. Evans, Mayor, will vote on $57,000 bond issue Nov. 21 for improvements to water and light plants, also ice plant. W. R. Rollins & Co., 521 R.R. Exchange Bldg., Kansas City, Engrs. Noted May 16.

N. Y., Bowmansville—The Bowmansville Creamery, Inc., A. Snell, Purch. Agt., is in the market for equipment for refrigerating and creamery plant.

N. Y., Brooklyn — The State Hospital Comn., Capitol, Albany, is having sketches prepared for addition to the Brooklyn State Hospital for Insane, here. Estimated cost $2,000,000. L. F. Pilcher, Capitol Bldg., Albany, Archt. and Engr.

N. Y., Brooklyn — The Sterling Private Hospital, c/o Timmis & Chapan, Archts. and Engrs., 315 5th Ave., New York, is having preliminary plans prepared for a 4 story, 100 x 100 ft. hospital on St. Johns Pl. Estimated cost $250,000.

N. Y., Buffalo—The Pillsbury Milling Co., A. C. Loring, Pres., 302 Metropolitan Life Bldg., Minneapolis, Minn., plans the construction of a flour mill here, 7,000 bbl. daily capacity. Estimated cost $2,500,000. Architect not announced. Quotations wanted on machinery for flour mill, including conveying and handling machinery.

N. Y., New York—N. J. Hayes, Comr., Water Supply Gas & Electricity, Rm. 2351, Municipal Bldg., received bids for the furnishing, delivering, installing and connecting a centrifugal pump for auxiliary pumping station at Southfield Bend, from J. W. Hooley, 45 Barclay St., $2,633; Ranson & Anderson, 136 Liberty St., $2,921; Turbine Equipment Co., 50 Church St., $2,950. Noted Oct. 10.

N. Y., Patchogue—The Bd. Educ. will receive bids until Nov. 4 for a high school. Estimated cost $500,000. Tooker & Marsh, 101 Park Ave., New York, Archts. Equipment detail not reported. Noted Oct. 3.

N. Y., Perry—The Fanning Co., Inc., is in the market for refrigeration machinery and equipment for proposed 1,800 ton ice plant. Contract awarded for construction to W. A. Austin.

N. Y., Rochester — The Brighton Place Dairy Co., 1757 East Ave., is in the market for refrigeration machinery and equipment for building now under construction.

N. Y., Tupper Lake — The Bureau of Yards & Docks, Navy Dept., Wash., D. C., rejected bids received Oct. 11 for the construction of a U. S. Veteran Hospital, here. Bids will be re-advertised. Noted Sept. 26.

N. Y., Tupper Lake — The Bureau of Yards & Docks, Navy Dept., Wash., D. C., will receive bids until Nov. 15 for coal and ash handling equipment, here.

N. C., Charlotte — The Southern Power Co., Church St., plans to build a steam power plant to generate 40,000 hp. at Mount Holly and one of 20,000 hp. at Enno, both to be used as auxiliary plants in times of low water. W. S. Lee, 309 East Moorehead St., Engr.

Ohio, Caldwell—The Caldwell Collieries Co. plans to rebuild its generating and hoisting plant which was destroyed by fire at the Florence mine. Estimated cost $70,000.

Ohio, Cleveland—The Bd. Educ., F. G. Hogan, Dir., East 6th St. and Rockwell Ave., will receive bids until Nov. 6 for a 3 story school addition, including steam heating system, on West 10th St. and Tremont Ave. Estimated cost $600,000. W. R. McCornack, East 6th St. and Rockwell Ave., Archt.

Ohio, Cleveland—The city plans the construction of a reservoir, administration building, chemical, gate and pressure houses and power plant at the Baldwin site. Estimated cost $4,500,000. A. V. Ruggles, City Hall, Engr.

Ohio, Columbus—The Amicon Fruit Co., 81 East Naghten St., is in the market for refrigeration and cold storage machinery and equipment for new cold storage plant at Williamson, W. Va.

Ohio, Columbus—The National Ice & Storage Co., G. R. Bassett, Purch. Agt., 5th and Naghten Sts., is in the market for complete ice manufacturing equipment, electrically driven. About $10,000.

Ore., Portland — The Regent Apartment Hotel, c/o C. L. Linde, Archt., Artisans Bldg., will receive bids until Nov. 18 for a 9 story, 100 x 100 ft. hotel on 13th and Salmon Sts. Estimated cost $350,000. Equipment detail not reported.

Pa., Blossburg—W. T. Merrick, Wellsboro, representing owner, plans to build a light and power plant here. Estimated cost $25,000.

Pa., New Brighten—The Beaver County Light Co., L. A. Witty in charge, plans to build a substation, here. Estimated cost $30,000. H. L. Fullerton, 5444 Kincaid St., Pittsburgh, Engr.

Pa., Wilkes-Barre—The Candlemas Collieries Co., Coal Exchange Bldg., plans to install electric power equipment in coal colliery.

Pa., Wilkinsburg — The Wilkinsburg-Plaza Hotel Corp., c/o A. A. Rockoff, 323 South Ave., will soon receive bids for a 9 story apartment hotel including steam heating system. Estimated cost $2,500,000. B. J. Levitan, 7 West 45th St., New York, Engr. Noted Aug. 8.

Tex., Cuero—The Cuero Light & Power Co. plans a $75,000 bond issue for extensions and improvements to its lines and plants here.

Tex., Galveston—The state, Bd. of Regents, University of Texas, Austin, is having plans prepared for a 3 story, 150 x 200 ft. medical college and separate power plant. Estimated cost $400,000. Herbert M. Green Co., North Texas Bldg., Dallas, Archts.

Wis., Antigo—The Crocker Chair Co., F. Levans, Mgr., is receiving bids for 2 tubular boilers and power house equipment for chair factory. Private plans.

Wis., Appleton—T. Heide, 635 Appleton St., is in the market for refrigeration machinery.

Wis., Madison—The Jackson Clinic Co., J. W. Jackson, Mgr., 110 N. Hamilton St., is having plans prepared for a 75 x 200 ft. clinic building, including steam heating system, equipment and remodeling old building, on Hamilton St. Estimated cost $250,000. F. H. Ellerbe, 692 Endicott Bldg., St. Paul, Archt.

Wis., Neenah—The city, c/o H. S. Zemlock, Clk., City Hall, plans to install new pump and equipment for waterworks system and pumping station. Engineer not selected.

Wis., Plymouth—The Phenix Cheese Co., R. A. Harbach, Mgr., is having plans prepared for a 5 story, 30 x 60 ft. cheese factory and separate boiler house. Electric power and motors, a.c. 220-60 cycle, and 30 ton ice machine, steam driven, will be installed. Noted Sept. 5.

Wis., Wausau—The Fraternal Realty Co., H. E. Schuler, Pres., is receiving bids for a steam heating plant, including boiler, for store, office and lodge building. Estimated cost $25,000. Private plans.

Wyo., Casper—W. W. Ahlschlager, Inc., Archt., 65 East Huron St., Chicago, plans to build a hotel, here, including steam heating system. Estimated cost $750,000. Owner's name withheld.

Wyo., Cody—W. W. Ahlschlager, Inc., Archts., 65 East Huron St., Chicago, plans to build a hotel, here, including steam heating system. Estimated cost $750,000. Owner's name withheld.

Wyo., Sheridan—W. W. Ahlschlager, Inc., Archts., 65 East Huron St., Chicago, plans to build a hotel, here, including steam heating system. Estimated cost $750,000. Owner's name withheld.

Wyo., Thermopolis—W. W. Ahlschlager, Archts., 65 East Huron St., Chicago, plans to build a 5 story hotel, here, including steam heating system. Estimated cost $1,000,000. Owner's name withheld.

Ont., Brantford—The Brantford Arena Co., A. Ballyntyne, Pres., is having plans prepared for an ice arena. Estimated cost $200,000. Prices wanted on equipment for making artificial ice.

Ont., Huntsville — The Muskoka Wood Mfg. Co. is in the market for a 700 hp., 3 phase, 60 cycle electric generator.

Ont., Tillsonburg—The Lorne Tractors, Ltd., H. Carmichael, Mgr., St. Thomas, plans to enlarge tractor plant, here. Estimated cost $100,000. Prices wanted on equipment, gasoline engines, etc.

Australia, N. S. W., Sydney—The L. P. R. Bean & Co., Ltd., 229 Castlereagh St., wishes to get in touch with manufacturers of the following: power plant machinery for telegraph and telephone, high tension insulators, hydro-electric machinery for generation and distribution of electrical power, turbo generators for central electric power station, high and low tension transformers and switchgear, motors and generators from fractional to 2,000 hp., ventilating plants for factories and buildings, refrigerating machinery for restaurants, hotels and domestic use, electrically operated ice making machines, farm lighting plants and systems, X-ray and kindred electro-medical and dental equipment, radio valves and other apparatus and high speed telegraph systems.

H. T., Pearl Harbor—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., will soon receive bids for a refrigerating and ice making plant, including equipment, capacity 3,000 lbs. per 24 hrs., at the Naval Operating Base Hospital, here. Spec. 4735.

CONTRACTS AWARDED

Calif., San Francisco—The Sacramento-Powell Co., c/o Macdonald & Couchot, Archts., 234 Pine St., awarded the contract for a 9 story apartment building on Powell and Sacramento Sts., to Macdonald & Kahn, 130 Montgomery St., $500,000. Equipment detail not reported.

Ga., Atlanta — The Dinkler Hotel Co. awarded the contract for the construction of a 12 story addition to the Ansley Hotel on Forsyth St., to H. J. Carr & Co., Candler Bldg. Estimated cost $270,000. Additional equipment not reported.

Ill., Chicago—Levy & Kline, Archts., 111 West Washington St., awarded the contract for a 2 story, 82 x 227 ft. store, office and apartment building, including steam heating system, on State St. and Bellevue Ave., to Kadeshewitz & Buckel, 1305 Independence Blvd. Estimated cost $500,000. Owner's name withheld.

Mass., Lowell—The Boott Mills, Armory St., will build, by day labor, under supervision of engineer, a hydro-electric generating plant. Estimated cost $40,000. A. P. Safford, 66 Bway., Engr. Noted Jan. 17.

Mass., Northampton — Quartermaster Corps., War Dept., Wash., D. C., awarded the contract for a U. S. Veterans' Hospital, here, to the Geo. A. Fuller Co., 949 Bway., New York, $2,117,000. Equipment detail not reported.

Mass., Worcester—The city School Board awarded the contract for a 3 story, 181 x 268 ft. junior high school, on Arthur, Grafton and Dorchester Sts., to L. Rocheford & Son, 44 Front St. Estimated cost $700,000. Steam heating system will be installed. Noted Aug. 15.

Mo., St. Louis—The Bd. Educ., 9th and Locust Sts. awarded contracts for a 3 story, 410 x 410 ft. Theodore Roosevelt high school as follows: building to the E. C. Gerhard Bldg. Co., Post-Dispatch Bldg., $1,148,000; all blast fan heating and ventilating system, tunnel distribution, 3 air fans, direct air washer of 210,000 cu.ft. capacity, heating and ventilating pumps, to Sodemann Heat & Power Co., 2306 Morgan St., $117,847; two 350 hp. water tube boiler with chain guide stokers to the John O'Brien Boiler Works, 1601 North 11th St., $29,355; 2 steam generators, one 200 kw. and one 100 kw. and a gas driven watchman and emergency generator to the Ridgway Dynamo & Engine Co., Chemical Bldg., $16,888; 7 panel 17 ft. switchboard to the E. A. Koeneman Electric Co., 1420 Pine St., $4,200.

Mo., St. Louis — The Liberty Hospital Assn., Pendleton and Delmar Aves., awarded the contract for a 4 story, 40 x 200 ft. hospital on Washington St. and Taylor Ave., to the H. O. Hirsch & Co., Wainwright Bldg. Estimated cost $250,000. Equipment detail not reported.

Neb., Beatrice—The Paddock Hotel, c/o W. H. Hepperlen, awarded the contract for a 5 story, 75 x 142 ft. hotel on 6th and Court Sts., to the Jas. Black Masonry & Contracting Co., World Theatre Bldg., Omaha. Estimated cost $300,000. Equipment detail not reported. Noted Apr. 11.

N. J., Atlantic City—S. K. Boniface, New Clarion Hotel, awarded the contract for a 6 story, 41 x 69 ft. hotel on Kentucky Ave., to W. M. Knauer, 132 South New York St. Estimated cost $500,000. Steam heating system will be installed.

N. Y., New York—J. Axelrod & Co., 200 West 72nd St., will build by separate contracts a 15 story, 87 x 102 ft. apartment hotel on West 71st St., west of Central Pork West. Equipment detail not reported.

N. Y., New York—The Greenwich Village Bldg. Corp., J. Wacht, Pres., c/o J. M. Felson, Archt. and Engr., 1133 Bway., will build by day labor, a 9 story, 80 x 102 ft. apartment building, including steam heating system, at 15 West 11th St. Estimated cost $500,000.

Ore., Grants Pass—The Irrigation Dist., Bd. of Directors, awarded the contract for 2 units of centrifugal pumps, one 9,000 g.p.m., 154 head, 450 hp. motor and one 4,500 g.p.m., 141 head, 200 hp. motor, directly connected, automatic compensator control, to the De Laval Steam Turbine Co., L. C. Smith Bldg., Seattle, Wash., $7,570. Noted Oct. 3.

Pa., McKees Rock — The Chesebrough Mfg. Co., 17 State St., New York, awarded the contract for a 2 story, 143 x 195 x 106 x 190 ft. finishing building, 1 story, 36 x 39 ft. boiler house, 1 and 2 story, 31 x 103 tank house to the Henry Shenk Co., Century Bldg., Pittsburgh. Estimated cost $200,000. Two 300 hp. boilers will be installed in power house. This is the first unit of a $1,000,000 manufacturing plant to be erected here. Noted Oct. 3.

Pa., Sharon—The Bd. Educ., c/o W. H Whitehead, awarded the general contract for a 3 story, 171 x 195 ft. high school, including indirect heating and ventilating systems, to Chas. Shutrump & Son's Co., 407 Home Savings & Loan Bldg., Youngstown, Ohio, $407,000. Noted July 4.

Tenn., Memphis—The Memphis Artesian Water Co., awarded the contract for the substructure of a new city pumping station, main grading, construction of a reservoir and equalization station, aerator and iron removal plant, conduits, main c.i. piping, valves, sluice gates, filter controllers, meters and fittings, to D. D. Thomas & Son, 463 North Dunlap St., $516,718. Daily capacity of pumping station will be increased to 25,000,000 gal. per day, maximum. Noted Sept. 6.

Wis., Baraboo—G. McCarthur & Sons Co. will build by day labor a 1 story, 50 x 65 ft. power plant. Estimated cost $40,000. The owner is in the market for power machinery, generator and waterwheel. Noted July 18.

Wis., Clyman — The Reeseville Canning Co., Reeseville, will build by day labor a 1 story, 70 x 162 ft. warehouse, 1 story, 64 x 90 ft. boiler house and 1 story, 70 x 120 ft. machine room. Estimated cost $75,000. Is in the market for 2 power boilers, 120 to 125 lb. pressure, for feed water heater.

Wis., Delevan—The State Bd. of Control, M. J. Tappens, Secy., Madison, awarded the contract for a 1 story cold storage building, here, to Lipman Mfg. Co., Beloit. Estimated cost $40,000. The owner is in the market for ice making machinery. Noted Oct. 3.

Wis., Green Bay—The Fairmont Creamery Co., 200 North Bway, awarded the contract for a 2 story, 100 x 105 ft. dairy, power and boiler house, to L. M. Hauser & Co., 113 West Walnut St. Estimated cost $60,000. Noted Oct. 3.

Wis., Mosinee — The Wausau Sulphite Fibre Co., O. Bachewig, Mgr., will build by day labor a 1 story, 60 x 100 ft. power plant. Estimated cost $50,000. Private plans. The owner is in the market for 2,500 hp. turbine spill gate, power plant machinery and equipment.

Wis., Waukesha—The Lux Fibre Furniture Co., 821 Meadow St., will build by day labor, a 1 story, 50 x 90 ft. power plant. Estimated cost $40,000. Owner is in the market for power plant equipment.

Ont., London — The Western University Bd. of Governors, A. T. Little, Chn., awarded the contract for a 2 story, 60 x 100 ft. central heating plant to P. H. Secord & Sons, 133 Nelson St., Brantford, estimated cost $50,000, smokestack to the Webber Chimney Co., 332 South Michigan Ave., Chicago. Noted Aug. 22.

Ont., Toronto—The Ford Motor Company of Canada, 672 Dupont St., will build a 1 story, 350 x 650 ft. automobile factory on Danforth Ave. Estimated cost $500,000. Will probably install steam heating system, machine shop equipment, etc.